The Seattle Municipal Water Plant

Historical
Descriptive
Statistical

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L. B. YOUNGS
Superintendent

Written by
JOHN LAMB
Chief Clerk and Auditor

January 1, 1914

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Superintendent of Water

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PREFACE

The mass of material constantly needed for reference, in connection with the Municipal Water System—material which is scattered in hundreds of books and documents in the various city offices—together with the historic and economic interest which the people of this city naturally feel in a great public utility which has grown from nothing to a plant representing an investment of more than $12,000,000, and which is now supplying water to practically every home and business establishment in the city, has prompted the compilation of this report in the extended form in which it appears.

From all parts of the country, and sometimes from foreign countries, inquiries are constantly coming to the Water Office for general information with reference to the plant. The time consumed in answering these inquiries is considerable, as the facts desired must generally be gathered from different sources and compiled. The greater part of these inquiries will be answered in this book, and can be quickly transcribed without further compilation. This is true also as to the inquiries from citizens of Seattle. Every election some matter concerning the plant comes up for decision by popular vote. At such times the local interest becomes great, and the leading facts about the plant are much in demand. Our high schools and University make special studies of the plant and the students are very earnest searchers for information concerning it.

The compilation of this report was made by John Lamb, Department Auditor, whose long familiarity with water department affairs peculiarly qualified him for this work.

Reviewing the whole period from the year 1888 when the first official action was taken toward securing the water plant, down to the present time, I have been much impressed with the great fidelity and devotion of our public officials to the task of developing the plant and making it a means of valuable service to the people of this city. I wish also to pay just tribute to the hundreds of men who have filled positions of trust and responsibility in connection with its affairs. I also wish to express my great appreciation for the unwavering encouragement and support of the various City Councils, and Chief Executives of the city, and the general body of our citizens, whose assistance has been in large measure the means of conducting to its present standard of usefulness and success this great public utility.

L. B. Youngs
Superintendent.

Superintendents of the City Water Department, and their term of office:

W. T. PRESTON, appointed Oct. 18, 1890.

J. F. PRATT, appointed Dec. 11, 1890.

W. T. CHALK, appointed Dec. 23, 1890.

F. W. WALD, appointed Sept. 16, 1891.

DUBOSE FITTEN, served May 19, 1892, to June 6, 1892.

W. E. WILSON, served June 7, 1892.

R. H. CALLIGAN, appointed April 1, 1893.

ANDREW JACKSON, appointed Feb. 15, 1894 (as member of B. P. W.), (served as Supt. of W. W.).

L. B. YOUNGS,, Feb. 11, 1895 (appointed as member of B. P. W., serving as Supt. of W. W.).

L. B. YOUNGS, appointed Supt. March 23, 1896, for term ending Dec. 31, 1898.

L. B. YOUNGS, appointed Supt. Dec. 31, 1898, for 3 years, term ending, Dec. 31, 1901.

L. B. YOUNGS, appointed Supt. Dec. 23, 1901, for 3 years, term ending Dec. 31, 1904.

L. B. YOUNGS, appointed Supt. Dec. 30, 1904, for 3 years, term ending Dec. 31, 1907.

L. B. YOUNGS, appointed Supt. Jan. 6, 1907, for 3 years, term ending Dec. 31, 1910.

L. B. YOUNGS, appointed Supt. Dec. 26, 1910, for 3 years, term ending Dec. 31, 1913.

L. B. YOUNGS, appointed Supt. Dec. 29, 1913, for 3 years, term ending. Dec. 31, 1916.

DUTIES OF SUPERINTENDENT

Section 9, Article VIII, of the City Charter, as amended March 4, 1913, reads as follows:

Sec. 9. *Department of Water Works: To Enforce Ordinances, Contracts, etc.*: In the department of public works there shall be a department of water works, the head of which shall be the superintendent of water works. He shall be appointed by the Mayor, by and with the advice and consent of the City Council, for a term, except as herein otherwise provided, of three years. He shall be a member of the board of public works. It shall be the duty of the superintendent of water works to rigidly enforce the provisions of all water contracts. He shall, subject to the control of the board of public works, have the management and control of the operation and maintenance of the water system of the city, including all buildings and grounds belonging to the water system, together with all lands and other property acquired for the water system for watershed or right of way purposes. He shall enforce all ordinances and the rules of the board relating to his department; he shall appoint under civil service rules, supervise and control all officers and employes of his department. He shall cause to be kept proper accounts with all consumers of water, and shall, every ninety (90) days, compile a statement of the names and property of such consumers as are delinquent, and shall forthwith cause the service of these consumers to be discontinued. The superintendent of water works shall have such further powers and perform such other duties as are provided by this charter, or shall be prescribed from time to time by the City Council or the board of public works.

Historical

As may be surmised, the first water system in Seattle was of a very primitive character. Before any streets were graded and when the westerly slope of the First Hill was in its natural condition, a stream of considerable size had its origin in a depression which began at the corner of Eighth Avenue and Madison Street, and extended almost due south, passing diagonally across each block, from the point of its origin down to the corner of Fourth Avenue and Yesler Way; thence across Yesler Way and through the center of the blocks between Third and Fourth Avenues South, emptying into the tide flats in the vicinity of Main Street. Just south of Yesler Way a draw or depression branched off in a south-easterly direction, reaching the tide flats near the point where the new Richmond Hotel now stands, between Fourth and Fifth Avenues South. This depression did not have a water course, and is distinct from the gulley in which the original stream ran, which supplied the first water system for the City of Seattle.

The first water system was installed when Henry L. Yesler built a small tank east of the alley in the block where the old City Hall used to stand between Third and Fourth Avenues. From this tank he conducted water, in an open V-shaped trough, to his mill, at the foot of Mill Street, which is now known as Yesler Way. This trough was afterwards replaced with 2 inch wooden pipe, made by boring 12 inch logs in sections of 6 foot lengths, and connecting them with a wooden spigot driven into the ends of the sections of pipe, so as to hold them together and convey the water. A section of this pipe was dug out on Yesler Way, just south of the Occidental Block, between Second Avenue South and Occidental Avenue, in March, 1913, with a connecting spigot, both in a fine state of preservation. It was taken out when the workmen were digging for the sewer of the new 42-story Smith Building, and thus old Seattle and greater Seattle met in a very unexpected way under some 17 feet of earth, sawdust and shavings. The pipe was imbedded in this sawdust and shavings, showing that waste material from the mill was deposited at that locality, both before and after the old wooden pipe had been installed.

The volume of water in the stream referred to must have been considerable, as it was used to furnish power, by an overshot wheel, for

Woodin's Tannery, which stood just south of Yesler Way, on the site of the present Prefontaine Building. Some of the wheels of this old tannery were found when the excavation was being made for the basement of the Prefontaine Building in 1910.

The old brewery which was just north of Yesler Way and east of the alley which ran in the rear of the Old City Hall, obtained its water from the same stream

Subsequent to the establishment of the old Yesler System, Charles Plummer, who owned a dock at the foot of Main Street, installed two hydraulic rams on the tide flats, near the corner of Second Avenue South and Main Street, taking his water from springs on the hill side about four blocks east, and raising it over an elevation of ground some 12 or 15 feet high, which lay between the rams and his dock on the water front. This elevation of ground extended southward a considerable distance out into the flats, dividing the tide flats from the waterfront west of First Avenue. The outer end of this elevated section was originally covered with timber, and both First Avenue South and Occidental Avenue were on this elevated section.

The first sluicing of earth by water in Seattle, perhaps the first in the State of Washington, was done by Henry L. Yesler, by cutting away the hill which then existed on the site of what is now the Starr-Boyd Block, to fill the site of what is now the P. S. T. L. & P. Co.'s power house. This water was taken from the creek above described.

At a later date Yesler built a small box in the creek near the southeast corner of Seventh Avenue and Cherry Street, on what is now the John Wenzler property, and conducted water to two tanks each about 20 feet by 40 feet in size, situated in the neighborhood of the alley between Fifth and Sixth Avenues on the south side of James Street. Yesler had also a second source of supply at Seventh Avenue and Columbia Street, where he sank a box in a spring called the Lowman Spring. This source of supply was investigated by Mr. Edwin Shepard, of the Spring Hill Water Co., after that company had purchased the system. He reported the water dangerously near sources of contamination from adjacent houses, and cut the spring off. The spring at the corner of Seventh Avenue and Cherry Street was still flowing through a ¾ inch pipe when the break in the Cedar River pipe line occurred in November, 1911, and people in the vicinity supplied themselves with water from that source. The water was analyzed by the Health Department and pronounced pure at that time. It was turned into the sewer when the public drinking

fountain was built on Seventh Avenue, just north of Cherry Street, in the summer of 1912. There is still some water coming through the retaining wall on the south side of James Street, in front of Number 619, where a small concrete receptacle, holding about 15 gallons, still exists for holding the water. A public drinking cup hung at this place until recently.

James McNaught had a system which covered the territory between Sixth and Eighth Avenues South and Lane and Dearborn Streets. His tank was in the neighborhood of Eighth Avenue South and Main Street. This system was taken over by the Spring Hill Water Co. and disconnected from its source. McNaught ran a pipe for part of his supply for this system as far north of Yesler Way as Sixth Avenue and Terrace Street. This system supplied about 100 houses. There is no record of any ordinance giving a franchise for this system.

W. I. Wadleigh also had a small system near Columbia and Fifth Avenue. His tank was at the junction of these streets. There is no record of a franchise from the city.

The first pipes installed were constructed by Rev. Daniel Bagley by taking logs and boring them with hand augers from 1½ to 2 inches in diameter, as above described. About 2,000 feet of this sort of pipe was installed for the University and the old Denny Home, and the water was brought from a spring in the vicinity of Sixth Avenue and University Street. There is no record of a franchise from the city.

The Denny-McCombs System was built at a later date by James McCombs, who is now (1914) located on a farm a few miles north of the city. Mr. McCombs drove a pipe horizontally in to the hill at Ninth Avenue and Union Street, a distance of about 150 feet, securing an ample supply of water for the needs of the people in that vicinity. Although this water was originally conveyed in bored wooden pipes, these were subsequently replaced with 4 inch iron pipe, after a tank had been erected for the Denny System on the side hill at Ninth Avenue and Union Street.

The Humphrey Jones System, which used to furnish several houses north and south of Yesler Way, in the vicinity of Third, Fourth, Fifth and Sixth Avenues, secured its supply of water by tunneling into the hill just north of Terrace Street and east of Sixth Avenue. The entrance to this tunnel may still be seen in the tract at the northeast corner of these two streets, the lot being still vacant. The concrete tank can be

seen on the lot at the southwest corner of Sixth Avenue and Jefferson Street.

The Coppin System was supplied by pumping from a deep well situated on the block just south of the present Catholic Cathedral. It supplied nearly 300 houses in that vicinity. It was bought from Dexter Horton & Co. for $200, under Ordinance No. 5246, approved February 21, 1899.

The Pontius System came from the side hill, southeast of Lake Union, near the junction of Melrose and Republican Streets, and supplied a large number of houses in the low district west of Eastlake Avenue and south of Lake Union. Can find no ordinance granting franchise for the Pontius System.

The Union Water System was one of the largest of the old systems. It was incorporated Feb. 27, 1882. The incorporators were D. T. Denny, Edgar Bryan, Walter Graham, Samuel T. Milham, James McCombs and William T. Graham. This company secured their first supply from springs in the vicinity of Fourth Avenue North and Ward Street, where the Queen Anne Pumping Station is now located. The volume of these springs was some 80,000 gallons per day. But this supply proved inadequate, and an attempt was made to supplement it by pumping from a well bored at the top of Queen Anne Hill, where the company built a large wooden tank. This well was sunk to a distance of 348 feet, but when the pumps began to work the supply in the well was found to be inadequate, there being apparently no artesian quality to the water, so the well was bandoned, and a pump was installed down on the shore of Lake Union, and the tank on the top of the hill was supplied by direct pumping. The pipes in this system were all originally wooden bored pipe, except that the pressure pipe used to pump the water from Lake Union was iron.

The Maggs System had its origin in a spring which was located between Sixth and Seventh Avenues North, between Garfield and Galer Streets. This system supplied a considerable territory in that vicinity, and as far west as Roy Street and Second Avenue North, and was doing business until about 1911, when the grading of Dexter Avenue made the system practically inoperative.

The franchise for this system was granted by Ordinance No. 1188, approved Aug. 26, 1889, and covered the territory described as follows:

Beginning at the foot of Battery St., thence along that street to Denny Way, thence along Denny Way to Fairview Ave., thence along Fairview Ave. to Lake Union, thence along the shores of Lake Union in a northerly direction to the northern city limits, thence following the city boundary west to 6th Ave. No. produced, thence along 6th Ave. No., south to Aloha St., thence along Aloha St., west to 4th Ave. No., thence along 4th Ave. No. south to Valley St., thence along Valley St. west to Elliott Bay, and thence along the shores of Elliott Bay to the foot of Battery St.

The Griffith System was built by L. A. Griffith in 1888. This had its origin on the north side of Queen Anne Hill near Florentia and Evanston Streets (the latter street being now Third Ave. No.) and supplied the greater part of Fremont.

After the condemnation of the right of way for the Lake Washington Canal in 1897 this system was discontinued, the city supply taking its place.

The Kinnear System which is still in operation comes from a spring in Block 4, Comstock Addition, and supplies 12 lots north of Queen Anne Drive in the replat of Block 8, Lots 1, 2 and 3, Block 11, and the Delmar Apartments on Lots 12 and 13, Block 16, all in G. Kinnear's Supplemental Addition. It was installed in 1888. The water has been repeatedly analyzed, always giving the highest percentage of purity. The flow fills a 4 inch pipe at the spring head where there is no perceptible difference in the supply, summer or winter.

The franchise for the Peterson System was granted by Ordinance No. 1300, approved Feb. 24, 1890. This franchise grants to Nils B. Peterson the right to lay water pipes within the area between W. Galer Street and W. Prospect Street, and from Willard Avenue to Railroad Avenue, covering the territory known as Crown Addition on the southwest slope of Queen Anne Hill and also the Second Supplemental Addition to Crown Addition. The other Peterson System is on the north slope of Queen Anne Hill and was installed about 10 years later by a different person.

The old franchise ordinances varied a great deal in their terms, some being for limited areas and others covering all the streets and alleys in the city. Most of them specified twenty-five years as the time during which the franchise should run, and fixed a period of 10 to 12 years from date of franchise as the time when the city might appraise, condemn and take over the property. None of them gave exclusive rights to lay pipes in

any street; all of them expressly reserving such rights. Under these franchises there might have been several pipes laid parallel to other lines in any street of the city. They were all very explicit in requiring the owners of each system to take good care of excavations made in the streets and to assume all responsibility for accidents and damages.

Subsequent to 1890 many small suburban systems were put into operation, and were afterwards purchased by the city, donated or abandoned. Among those purchased were

The Ballard System, acquired in 1907 for	$77,000.00
The Home Seekers System, acquired in 1908 for	2,500.00
The Rainier Valley System, acquired in 1908 for	33,200.00
The Columbia System, acquired in 1908 for	4,980.00
Part of the Georgetown System, acquired in 1910 for	7,532.00
The Fairmount System in West Seattle, acquired in 1910 for	1,764.27
The Euclid Heights System in West Seattle, acquired in 1912 for	280.00

and the following systems acquired without cost or abandoned between 1900 and 1913:

The South Seattle System, acquired in	1910
The Kenyon Street System, acquired in	1912
Union Trust Co. System, acquired in	1912
Lake Washington Mill System, acquired in	1912

The Nils Peterson System on the south side of Queen Anne Hill, abandoned by the company.
The Northern Pacific and Great Northern Systems at Interbay, abandoned by the companies.
The York System, abandoned by the company.
Montana Addition System, abandoned by the company.

The Peterson System on the north slope of Queen Anne Hill still supplies a few houses. No franchise was granted for this system as it was on Mr. Peterson's land, taking water from a spring in the ravine near Third Avenue West and Ray Street.

Practically every spring and watercourse within the boundaries of the city has been used at some time as a water supply by piping to residences in the neighborhood of its location. A few of these on the outskirts are still in operation.

There does not appear to have been any legislation regulating the charges for water, or the conditions under which it should be supplied, until the organization of the Spring Hill Water Co., which was incorporated on August 20, 1881, the capital stock being $25,000.00, and the trustees being: Louis Sohns, T. H. Cann, Amasa S. Miller, T. Hanford, Louis R. Sohns and J. R. Lewis. This company received its first water supply from the west side of the First Hill and erected tanks of various sizes on the slope, mainly toward the south end of the city.

They also bought a few small water systems, including the McNaught and the Yesler Systems. They had as many as a dozen tanks, large and small, the most important of which were one 26x48 feet in Plum Street, near Eleventh Avenue South; one 20x120 feet in the southeast quarter of the block bounded by Tenth and Eleventh Avenues South and Seattle and Massachusetts Streets, and one 24x170 feet, bordering on Eleventh Avenue South in the southwest quarter of the block between Eleventh and Twelfth Avenues South and Grand and Holgate Streets. All these were square wooden tanks.

In 1886 the company built Lake Washington Pumping Station and Beacon Hill Reservoir, and began pumping from the lake to the reservoir through the 12 inch kalamein force pipe on Holgate Street, which the company installed from their pumping station at the foot of Holgate Street on Lake Washington to the reservoir which occupied the whole block between Thirteenth and Fourteenth Avenues South and Plum and Holgate Streets. The elevation of the water in this reservoir was 312 feet above tide water, and the capacity 4,280,000 gallons.

The first ordinance establishing rates for water was No. 253, granting right of way to the Spring Hill Water Co., to lay water pipes and defining duties and obligations of said company, approved Nov. 12, 1881, by John Collins, Acting Mayor. The rates fixed by this ordinance were as follows:

Private families, all purposes, $1.50 per month.
Each lot 60x120 ft. for irrigation, $2.00 per year.
Steamers and vessels, 50c for first 1,000 gals. and 40c for each 1,000 gals. thereafter.
Hotels, 100 rooms, $5.00 per month, and for every additional 50 rooms or fraction thereof, $1.50 per month additional.
Livery stables, $3.00 per month.
Saloons, $1.50 per month.
Restaurants, $2.50 per month.
Barber shops with bath rooms, $2.50 per month.
Barber shops without bath rooms, $1.00 per month.
Stores and retail shops, $1.50 per month.
Manufactories, 30c for the first 1,000 gals. and 20c for each 1,000 gals. thereafter.
Laundries, consuming 300 gals. per day or less, $4.00 per month, and the same proportion for those consuming more.
For all other purposes, 50c for the first 1,000 gals. and 35c for every 1,000 gals. thereafter.

The terms of this ordinance were accepted by the Spring Hill Water Co. on Nov. 12, 1881, by vote of its Board of Trustees, Louis Sohns, President; T. Hanford, Secretary pro tem.

A second ordinance was passed, No. 883, and approved Dec. 3, 1887, fixing rates as follows:

For general household purposes, buildings occupied by a single family, covering a ground surface of:

	1 story	2 stories	3 stories	4 stories	5 stories
1,000 square feet or less	$1.50	$1.50	$1.75	$2.00	$2.25
1,000 to 1,500 square feet	1.75	2.00	2.25	2.50	2.75
1,500 to 2,000 square feet	2.25	2.50	2.75	3.00	3.25

For business establishments:

40 cents per 100 cubic feet for all bills exceeding $10.00 per month, 25 cents per 100 cubic feet for all bills exceeding $50.00 per month, and 20 cents per 100 cubic feet for bills exceeding $100.00 per month.

The above ordinances are interesting as they establish the first rates for water in the city. They were amended from time to time during the period that they were in operation.

Following the legislation from this original ordinance down we find that Ordinance No. 270 grants unto James McCombs and his associates the right to lay water pipes in all streets and alleys north of Madison Street. This ordinance was approved May 6, 1882. The Denny-McCombs System was built under this ordinance.

Ordinance No. 278, approved May 18, 1882, grants to Charles Coppin the right to lay water pipes in all streets and alleys within the city.

Ordinance No. 314, approved April 7, 1882, grants to John Leary and associates the right to lay water pipes in streets and alleys of the city. This was the Spring Hill System, which had passed from its original incorporators into new hands. This franchise covered all streets and alleys in the city.

Ordinance No. 373, approved April 23, 1883, grants the right of way to the Union Water Co. to lay water pipes in the streets and alleys of the city. This franchise covered all streets and alleys in the city.

Ordinance No. 381, approved May 11, 1883, grants to H. Jones the right to lay water pipes in all streets and alleys in the city.

In order to distribute the charges for fire protection where it was deemed they justly belonged, instead of assessing them on the general tax payer, Ordinance No. 598 fixed the limits of the benefits and protection afforded by the contract for the supplying of water, entered into with the Spring Hill Water Co. This Ordinance was approved Sept. 9, 1884. It was supplemented by Ordinance No. 600, approved Sept. 20, 1884, which levies a special tax for the payment of water rents against property so protected.

PURCHASE OF THE SPRING HILL WATER SYSTEM

The Spring Hill Water System was purchased under authority of Ordinance No. 1279, approved Jan. 25, 1890. The price paid was $352,265.67. A cash payment of $2,265.67 was made to bind the bargain, and the balance was paid after the sale of the bonds, which were authorized to the amount of $845,000.00 by vote of the electors on June 4, 1890. The vote on these bonds stood 705 for and 16 against. The bonds bore interest at 5% per annum. The final payment was made on Oct. 31, 1890.

From the proceeds of these bonds the Union Water Company's System was purchased under authority of Ordinance No. 1797, approved Aug. 15, 1891. The payment for the plant was to be $17,500.00, payable in nine equal monthly installments, and the assumption of a mortgage of $10,000.00 with interest which matured June 15, 1892. When the payments were all made the plant had cost the city $28,300.00.

The balance of the proceeds was used for extensions and betterments of the pumping and distribution system. Large quantities of pipes, hydrants and gates were bought in the summer of 1890 to extend the distribution system and make the new pumps properly available.

On Feb. 15, 1890, just 20 days after the purchase of the Spring Hill System, Ordinance No. 1294 was approved, which authorized the Mayor and City Clerk to enter into a contract for two high pressure Worthington pumps, with a combined capacity of 2,500,000 gallons per day, at a cost of $17,800.00. These were installed at Lake Washington Pumping Station to supplement the Dow pump of 2,000,000 gallons capacity per day, already in commission by the Spring Hill Company, thus making a total capacity of 4,500,000 gallons per day.

In a letter to the Council on August 11, 1890, Chief Engineer Benezette Williams said:

"Water pipes have been ordered laid along Rainier Street (now Thirtieth Avenue South) and Yesler Avenue, from the pumping works to Front Street (now First Avenue) through which, when laid, and connected with the old distribution system, 2,500,000 gallons per day can be supplied.

"On laying a new main from the reservoir to the city, and the further extension of the proposed distribution system, the Rainier Street and Yesler Avenue main from the pumping works will be capable of supplying 4,500,000 gallons per day. To do this pumps additional to those or-

dered of 2,000,000 gallons daily capacity will have to be obtained. The total capacity of the works at Lake Washington will then be 6,500,000 gallons in twenty-four hours."

"The system thus proposed," says Mr. Williams, "is but a makeshift, barely adequate to supply the low service district for two years.

"No adequate pumping system can be built and put into operation in much less time than two years, nor can it be done within the present limit of indebtedness.

"There is no alternative consistent with the safety of the city but to enter at an early date upon the building of the Cedar River Works as proposed, or to definitely abandon this plan and begin upon the construction of entirely new pumping works, force mains and reservoirs to supply fully both the high and low service districts from Lake Washington."

It is clear from the above statements of Engineer Williams that the city had come to the parting of the ways, and had to decide without delay in favor of one system or the other. There can be no question that the decision in favor of a gravity system was the wise one. Nevertheless the construction of gravity line No. 1 was not finished so as to deliver water until January, 1901, and in the meantime the city had to put in a 5,000,000 gallon pump in addition to the three pumps already installed.

On Sept. 15, 1891, Ordinance No. 1824 was approved. This ordinance authorized the Board of Public Works to purchase from the Holly Manufacturing Co. of Lockport, New York, a number 6-A pumping engine with a capacity of 5,000,000 gallons per day of 24 hours, at a price of $36,500.00. The installation of this pump raised the daily pumping capacity of the station to 10,000,000 gallons.

Nearly a year later, on July 27, 1892, Ordinance No. 2255 was approved, which provided for the construction of a brick pump house at Lake Washington Pumping Station and limiting the cost of the building to $10,000.00.

Ordinance No. 1955, approved Jan. 14, 1892, authorized the Board of Public Works to extend a 36 in. main from Lake Washington Pumping Station out into the lake a distance of from 550 to 850 feet, the pipe to be of wrought iron or steel with a proper inlet screen. The same ordinance authorized the construction of a 20 in. cast iron main from the pumping station to the reservoir, a distance of 7,400 feet.

The proceedings in connection with the purchase of the Spring Hill Water Plant, and the construction of the Cedar River Water Supply System took definite shape during the administration of Mayor Robert Moran, who was elected in 1888. Mr. Moran, as a member of the

Robert Moran

City Council in 1887, had served on the Fire and Water Committee and was thoroughly familiar with the needs of the city for water supply and fire protection. After his election he lost no time in urging upon the Council the necessity of securing public ownership of the water plant as it then existed, and the construction of a gravity system from Cedar River. The official correspondence and reports in connection with this initial and all-important event in the history of the water plant is well worthy of being printed, and it is here given in full, beginning with the original letter of Mayor Moran to the City Council.

Seattle, Sept. 24, 1888.

To the Common Council—Gentlemen:

I wish to call your attention to a matter which I think should have your careful consideration and prompt action at this time—that is, the future and permanent water supply of this city. This question, which has been agitating the minds of the citizens for some time, is whether the water system of this city should be owned and operated by the people or by private individuals. I think that this matter, which is of vital importance to the future city, should be settled now and before other private capital is invested in such works.

In calling your attention to this matter I recognize the rights of those, who, when we were without water for fire, manufacturing or domestic purposes, had the public enterprise and faith in the future of this city to make the investment which is now represented by our present water system. At no future time can this question be settled so equitably and satisfactorily to all concerned as now. I think the citizens of this city should be called upon to express themselves on this question at a special election, or the general election in November next, and determine finally whether this city is to have an abundant supply of pure water at cost, or continue to pay tribute to private individuals on all water used in the future.

I would recommend that for the guidance of the citizens in determining the question intelligently, you refer it to a committee of your honorable body to investigate and report on the probable cost of conveying water from Cedar River and distributing in this city by gravity. This plan is perfectly feasible. Its first cost may be more than that of pumping engines, but the operating expense of such a system would be nominal. Hoping these suggestions will meet with your approval and hearty co-operation. I am, respectfully,

ROBERT MORAN,
Mayor.

On Oct. 18, 1888, the Fire and Water Committee reported as follows:

To the Honorable the Mayor and Common Council of the City of Seattle:

Gentlemen:

Your Committee on Fire and Water, to whom you referred the message of his Honor the Mayor regarding the future and permanent water supply of the city, beg to report as follows:

Your Committee recommends that the council call upon the citizens of Seattle to declare at a special election for that purpose, to be held on the 19th day of November, 1888, whether they will authorize the issue, by the City of Seattle, of bonds to the amount of $1,000,000, or as much of the same as may be necessary for the construction of a system of water works, which will supply the city with water from Rock Creek, in the manner hereinafter described.

Your Committee has no doubt of the desirability of the city controlling its own water supply, neither has it any doubt but that a very large majority of the citizens will endorse this opinion at the polls. There are many reasons why the city should undertake this great work. It is rapidly increasing in population and wealth, and its resources and credit are so great that it is abundantly able to do so. The present water systems have become inadequate because the city has outgrown them. The quality of water supplied is by no means the best obtainable. The cost of water to the consumer is and must always be large when the same is obtained by pumping, either from wells or from the lakes. We ought not to be dependent in the matter of water supply, which may be called the life-blood of a city, on the caprice or rapacity of any corporation. Not that the City of Seattle has ever, so far, been imposed on by any of her water companies. The stocks of these companies have been up to the present time mainly owned by our own citizens, and this has been a measure of protection. But we have no guarantee for the future that this stock will not pass into foreign hands, who will not scruple to exact from us all that the business will bear and their charters authorize. Should the public own its water system there might rapidly be extended over the whole city a complete system of fire hydrants, which it is impossible to do by our present systems at present rates, as such rates would almost lead the city to the verge of bankruptcy. The city could also offer great inducements for the establishment of manufactures, and by this means increase our tax paying wealth to such a degree that the water rents of every individual in the city would decrease year by year. There are many other advantages which suggest themselves, not the least of which is the matter of health; when an abundance of water for the purpose of flushing our sewer and washing away the surface filth of the city is supplied, who can doubt that we will be both healthier and happier?

Your Committee next considered the feasibility of the city obtaining her own water supply. This consideration naturally divides itself into three parts: the legal, the engineering and the financial.

Under the charter, the City of Seattle has power to erect and maintain water works and to issue negotiable bonds or warrants for this purpose, payable at a stated time and drawing interest at a rate not exceeding 10 per cent per annum, these warrants to be redeemed and interest paid out of a specified fund. There is no limit except the will of the people, and the restrictions contained in the 4th Section of the Act of Congress of the 30th of July, 1886, (Pamphlet Laws of 1885-86, p. 171), to the amount of bonds for this purpose, which may be issued. Your committee would state that on this subject they have consulted several eminent legal counsellors.

Your Committee directed the City Engineer, J. G. Scurry, Esq., to prepare approximate estimates for the construction of a water system to be fed from Rock Creek, and would refer the Council for a full understanding of this portion of the subject to the excellent report of Mr. Scurry, which is hereto appended and made part of this report.

You will observe that Mr. Scurry estimates the total cost of constructing the complete system to the reservoir in Seattle at the sum of $764,980, exclusive of the distribution of the water through the city. Your committee desired him to make a liberal estimate, and he has done so. It is somewhat difficult to estimate the cost of distribution, as the field is constantly expanding, and by the time the conduit is completed the city will have greatly increased its population.

In the judgment of your Committee, the citizens of Seattle should be asked to authorize the issue of bonds not to exceed the sum of one million dollars, which amount will be large enough to cover the expense of constructing what will be the most complete and excellent water system of any city in the United States. You will note that the supply is calculated to be sufficient for a city of 100,000 population. When we exceed that number it will be very easy to parallel the proposed line and supply the same from feeders in the neighborhood of the head works on Rock Creek.

Your Committee has made inquiries of several prominent financiers as to the probable value of our bonds in the money markets of the world, supposing the bonds to be issued according to law, and are assured that the same can be placed at an interest charge of not exceeding six per cent per annum. Should the amount of bonds mentioned be necessary, the amount of interest to be raised every year would be, say $50,000. Your committee is of opinion that the best way to provide for the payment of the same, together with the operating expense, would be to collect from residents a very moderate water rent, and to levy a special tax on all the taxable property of the city to make up the balance in the manner provided for in Section 15 of the city charter. But this matter can be properly and fully considered in the future.

Regarding the head works, the right-of-way and the ground necessary for reservoirs your Committee is informed that the city is invested with full power to condemn property for the same.

Your Committee therefore recommend that as a commencement of this undertaking, the city clerk be instructed to publish a call for an election to be held at the usual voting places of the city on the 19th day of November, 1888, for the decision of the question, whether the City of Seattle shall incur an indebtedness not exceeding $1,000,000 for the purpose of constructing a system of water works to supply the City of Seattle with water, such construction and water works to be in general and substantial conformity to the plan and estimates set forth in the accompanying report of Mr. Scurry, and also all the necessary pipes, works and reservoirs for the distribution of said water throughout the city.

R. E. DURIE,
Chairman,
C. F. REITZE,
T. E. JONES.

WHAT IT WILL COST

Seattle, Oct. 19, 1888.

To the Chairman of the Water Committee, Seattle, W. T.:

Dear Sir:

In compliance with your instructions I herewith submit an approximate estimate of the cost of constructing a system of works designed to supply the City of Seattle with water.

The water is to be supplied by Rock Creek, a tributary of Cedar River, which takes its rise on the divide between Cedar and Green Rivers in Section 25, Township 22 North, Range 6 East, at an elevation of about 500 feet above high water at Seattle, and about 300 feet above the point at which it falls into Cedar River. The region in which this stream heads and through which it flows is unfitted for agriculture or lumbering, and not likely to be contaminated by manufacturing or settlement to any injurious extent. I know of no stream more eligibly situated for supplying the city with pure water. Its estimated hourly flow is between 550,000 and 650,000 gallons. (It is probably in excess of this.) The length of pipe required for the delivery of the water to the reservoir in Seattle is about twenty-two miles. The line will follow the ridge along the south side of Cedar River, and parallel with that stream, descending by a uniform grade for a distance of ten miles to a point near the village of Renton, thence descending into the valley formed by the junction of Cedar and Black Rivers, and running in a westerly direction crossing Black River, and ascending to the ridge, which it follows to a point on high ground near Seattle, to be selected as a site for a distributing reservoir.

The cost of the above described work will be, approximately as follows:

John G. Scurry

Opening and repairing roads for transport of material	$ 2,500
Clearing pipe line, to average 33 feet and cutting side timber, 80 acres	16,000
Grubbing and excavation and laying pipe	30,000
116,160 feet 30 inch steel pipe, ¼ in. thick at $5.50 per ft.	638,880
Transportation of pipe, 4,000 tons, at $1.50	6,000
Trestling	5,000
Total cash conduit	$698,380
Reservoir and head works—clearing and grubbing	1,000
Excavation and embank (tamping, etc.)	22,000
Concrete and asphaltum slope lining	15,000
Stone paving	3,600
Total	$41,600
Superintendence and contingent	25,000
Total cost conduit and reservoirs	$764,980

The works are intended to supply water for a population of 100,000. The total fall from the head works on Rock Creek to the distributing reservoir at Seattle is approximately three hundred (300) feet. A thirty (30) inch pipe with this fall should deliver daily 10,000,000 gallons or 100 gallons per head, which will amply meet all requirements for two or three years to come at least.

Respectfully,

JOHN G. SCURRY,
City Engineer.

Following the adoption of the report of the committee, the following resolution was prepared and published. This submitted the question of the city owning its own water supply from Cedar River, to the voters at the general city election to be held on July 8, 1889. Nothing further on the water question could be done until the vote of the people.

"Notice of submitting to the qualified voters of the City of Seattle at the general election of said city, to be held on the 8th day of July, 1889, the question whether or not the City of Seattle shall erect water works, and authorize the expenditure of a sum not exceeding one million dollars for such purpose.

"WHEREAS, By Section 12 of the Charter of the City of Seattle, it is provided that: 'The City of Seattle has power to erect and maintain water works, or to authorize the erection of the same for the purpose of furnishing the city with a sufficient supply of water, but no such works shall be erected by the city until a majority of the voters of the city, at a general election, shall vote for the same.'

"Now, therefore, notice is hereby given to all whom it may concern, that, on the 8th day of July, A. D. 1889, in said City of Seattle, in King County, Washington Territory, pursuant to the provisions of said section, at the general municipal election of said city, to be held on said day, there will be submitted to the qualified voters of said City of Seattle,

the question whether or not the City of Seattle shall erect such water works and authorize the expenditure of a sum not to exceced one million dollars for such purpose, as are in such section intended, and are described as follows, to-wit:

"A system of water works, for the purpose of furnishing said city with a sufficient supply of water; said system to consist of a suitable principal conduit pipe, and of a suitable distributing reservoir or reservoirs and head works and distributing mains, branches and hydrants, all well laid, constructed, protected and secured, and all necessary and proper appurtenances, and all interests in land necessary or proper for the erection or enjoyment of said works; said water to be supplied by such lake, stream, creek or other watercourse as may be deemed necessary by the City Council of the City of Seattle; the estimated cost of said water works being one million dollars.

"At said election the polls will be opened at 9 o'clock A. M. and closed at 7 o'clock P. M. Every voter who shall vote for erecting the above described water works and authorizing the expenditure of a sum not to exceed one million dollars for such purpose will vote a ballot containing the words, 'Water Works, Yes.' Every voter who shall vote against said water works will vote a ballot containing the words, 'Water Works, No.'

"Dated the 26th day of June, 1889.

"By order of the Common Council of the City of Seattle.

"ROBERT MORAN,
"*Mayor.*
"C. W. FERRIS,
"*Clerk.*

"Date of first publication, Friday, June 28, 1889."

The following statements from ex-Mayor Moran, made in 1913, shows the situation during 1889 and 1890:

"On June 6, 1889, occurred the great fire, which almost wholly destroyed the city, proving the absolute inadequacy of the city water supply.

"At the general election in July following, Mr. Moran was again elected mayor and at the same election, the voters decided with practical unanimity that the city should own its own water supply and that it should come from Cedar River.

"It goes without saying that the private water companies were strongly opposed to the city going into the water business, and made the utmost use of the press and courts to discredit and prevent the carrying out of the plan. I have often thought since what a rich and powerful monopoly a private water company would be in Seattle today.

"Following the vote of the people on the water question, negotiations were opened between the city and the Spring Hill Water Company for the purchase by the city of its entire plant. In the meantime, with the consent of the council Mayor Moran entered into a contract with a thoroughly competent water and sewerage engineer of Chicago, Mr. Benezette Wil-

liams, the result of which was that Mr. Williams came to Seattle and gave the plans of the water and sewerage system his personal attention, and those plans, then made, have been put into practical effect in the building of Seattle's present Cedar River water supply and sewer system, including the north and south sewer tunnels.

"It was upon Mr. Williams' detailed estimate of actual value that the city purchased the entire plant and property of the Spring Hill Water Company, under authority of Ordinance No. 1279, approved Jan. 25, 1890, the purchase price being $352,265.67. The company claimed a value of $840,000.00, but offered to sell for $600,000.00, and it was due largely to the technical knowledge and advice of Mr. Williams, that this fair purchase price was agreed on. A cash payment of $2,265.67 was made to the Spring Hill Water Company to bind the bargain until the city could sell its bonds. The bonds were sold and the balance of the purchase price, $350,000.00, paid to the company, October 31, 1890, after which the city proceeded to the construction of the present water system from Mr. Williams' plan, as modified by Mr. Thompson, the City Engineer."

In his message to the council transmitted on July 24, 1890, Mayor Moran makes the following statements and recommendations:

"The total sum in warrants issued against the water fund during the year amounts to $98,587.57. Of this amount $32,115.47 has been called in. This expenditure has mostly been made on the strength of the decision at the July election, 1889, by the people, that Seattle should own her own water works.

"The whole extent of country between Cedar River and the city has been thoroughly surveyed and the best possible line for a conduit determined and fixed in valuable data and maps. There has also been charged to this fund the cost of complete topographical survey of every portion of the city, recorded in maps and statistics most comprehensive and invaluable for water or sewerage as well as for street and other municipal purposes. The city has made a number of extensions of the Spring Hill mains, and has now under construction an addition to the pumping capacity of the Spring Hill Company's plant of 2,500,000 nominal gallons a day. The new pipe line through which this additional supply of water will be forced, and which is also intended to form an integral part of the new distribution system as planned by Engineer B. Williams, is almost completed, and the amount paid on this work is also charged to the water fund. This work is all of the best and most permanent nature, as is also the whole of the distribution system. The pipe is all of the heaviest cast iron except that which rests on piles, this being of steel. When the work is done it will last for generations.

"When the great fire had demonstrated the inadequacy of the Spring Hill System, the people, by an almost unanimous vote, at the general election in July, 1889, determined to erect a new system of water works, to be owned by the city. Overtures were made to the city by the

Spring Hill Company for the sale of their system. A special committee, consisting of Councilmen Durie, Jones, Twitchell and Niesz was appointed, empowered to negotiate with the company. After a long series of meetings with the representatives of the company, an agreement was come to and approved by the Council for the purchase of all the property of the company, including houses, pumps, mains, pipes, reservoirs and real estate consisting of 84 lots, for the sum of $352,268.46.* Of this sum $2,268.46 has been paid and the balance, $350,000, will be paid when the city realizes on the bonds which the people, on June 4, 1890, voted for this purpose.

"No action of any Council of this city is worthy of being called second in importance to this transaction. The city had got to the stage when the question whether we should control our own water supply or be under the power of a gigantic water corporation had confronted us and had to be decided. Happily this great question is now eliminated from the problems of the future. The permanent source of water supply for the city is the important question that will require the attention of and must be decided by our successors. The extensions now being made and which will be in operation in a few days, will, with the distribution system as planned by Mr. Williams, give the city an ample supply for its present population, and perhaps until such time as permanent works are constructed. But it is in my judgment absolutely necessary for the city to decide at once whether the permanent supply is to be pumped from Lake Washington or come by gravity from Cedar River. There are numerous reasons why this should be settled.

"*First*: A part of the distribution system can not be intelligently planned without that knowledge.

"*Second:* If it is decided that Lake Washington shall be the source of permanent supply, then the pumping station should be moved north to a point near the foot of Madison Street on the lake shore, so as to shorten as much as possible the distance from the pumps to the central portion of the city, where the greatest consumption will occur.

Third: In order to deliver the large amount of water this city will require in the near future, and at a minimum cost, large compound pumping engines of the most approved design should be purchased and set up at that point. The Spring Hill Water Company's pumps and the two lately purchased by the city are first-class machines within the capacity for which they were constructed, but it would be the height of folly for this city to go on and supplement the present plant by the addition of other small pumps beyond those now contemplated as the increased consumption demands. The added cost of moving large quantities of water by means of such machinery would, I believe, pay the interest on an expenditure necessary to construct large modern pumping engines which would move water with the minimum cost to the city. Such of the present small pumps

* These figures vary slightly from those given by Superintendent Wald in his report of December 31, 1891.

as would not be required by the city could be disposed of without much loss in value.

"In offering these suggestions I do not wish to be understood as advocating the use of Lake Washington water as the permanent supply for this city. I only indorse it to the extent we have now gone; that is, to relieve the present shortage and provide an additional supply pending the settlement of this great question of the future.

"In his report of February 21, 1890, the Chief Engineer estimated that the cost of works on the plan proposed by him to bring 25,000,000 gallons per day into the city by gravity from Cedar River, including the aqueducts, dams, and reservoir, will amount in round numbers to $1,200,000; which is $516,000 more than the estimated cost of new pumping works on Lake Washington that would furnish an equal amount of water in the city.

"At my request he has also made an estimate of the cost of work to furnish 10,000,000 gallons per day, 4,000,000 gallons into the high service reservoir and 6,000,000 gallons into the low service reservoir, on each of the two general plans, viz.: the Cedar River gravity plan and the Lake Washington pumping plan. The estimate is based upon a storage capacity for the high service reservoir of 10,000,000 instead of 26,000,000 gallons, upon riveted steel plate pipe, 30 inches in diameter, from Swan Lake to the city reservoirs instead of an asphaltum coated wooden pipe 42 inches in diameter, and upon an earthen flurre or ditch from Cedar River to Swan Lake, instead of one lined with plank and asphaltum, as proposed in his report.

"The reduction of cost which can be affected by these changes is estimated in round numbers as follows:

On pressure pipe from Swan Lake to the city	$162,000.00
Flume from Cedar River to Swan Lake	58,000.00
High service reservoir	40,000.00
Total reduction in cost	$260,000.00

which leaves $940,000 as the cost of the gravity supply works, as modified.

"The cost of new pumping works for 10,000,000 gallons capacity, with lake inlet, pumps, pump house, pump mains and reservoir, are roughly estimated at $460,000, which is $480,000 less than the gravity works of the same capacity.

"Thus it is seen that for works of 10,000,000 gallons daily capacity the Cedar River plan will cost $480,000 more than the Lake Washington plan, and that for 25,000,000 gallons daily capacity it will cost $516,000 more than the Lake Washington plan.

"Mr. Shepard, of the Spring Hill Water Works, and Mr. Williams, estimate that to pump 5,000,000 gallons per day with the old plant as now being enlarged will cost $29,700 per annum. If from this be taken the expense of caring for the gravity supply works, estimated at about $2,600 per annum, we have $27,100 per annum which will be saved to

the city by the use of gravity works when 5,000,000 gallons per day is being furnished for the low service; similarly when 10,000,000 gallons per day are being furnished—4,000,000 gallons per day for the high service and 6,000,000 for the low service—it is estimated that there will be an annual saving of at least $50,000.

"The former amount represents a capitalization at 5 per cent of $542,000 and the latter of $1,000,000.

"Thus it will be seen that when this city is consuming 10,000,000 gallons of water daily, which amount, I estimate, will be required in three years from the present time, the saving in the cost of operation alone of a gravity system from Cedar River by way of a 30 inch steel main over that of a pumping system from Lake Washington would pay the interest on the cost of the gravity system and leave a surplus of $3,000. But the question of cost, although important, is really secondary to that of the health of the community, and the quality of pure mountain water can not and will not be compared by any citizen with the water from Lake Washington. In my opinion it would be little less than criminal for any set of public servants to contemplate the erection at vast expense of permanent pumping works at the lake.

"In closing on this subject I want to go on record as follows:

"*First:* I recommend the completion of the purchase of the Spring Hill Water Company's plant, and that the city, on taking possession of the same, connect the new pumps through the Yesler Avenue main with the old system, thus re-enforcing it and giving a good supply in all the mains now laid.

"*Second:* Don't increase the pumping capacity at the lake to a greater total than the works now under construction will supply, to-wit, an average of 5,000,000 gallons, with a possible capacity of 7,000,000 gallons per day.

"*Third:* Carry out the plans of Mr. Williams for a complete distribution system, including a high service reservoir.

"*Fourth:* Construct the Cedar River gravity system with a daily capacity of 10,000,000 gallons, using steel plate pipe 30 inches in diameter, at a cost of $940,000, which I believe to be a conservative estimate of its cost. Let our people increase this plant as future consumption may require.

"I should like to have reviewed the evolution of the question of city ownership of our water supply during the two years of my mayoralty, but space forbids. I should like to trace the difficulties which have been met and conquered, the organized and persistent opposition of a small section of our citizens and of the public press to this great question at every stage of its progress from its inception, but it is not necessary, for I am confident that the pulse of the public beats in harmony with the views I have expressed, and that before long I shall see in successful operation, under city ownership, a magnificent system of water supply fed from the snow-clad Cascade range of mountains."

CREATION OF WATER FUND

The Water Fund was created as a distinct municipal fund by Ordinance No. 1536, published November 21, 1890. This ordinance was amended and substantially superseded by Ordinance No. 2733, approved April 29, 1893. The purchase of the Spring Hill System, the sale of $845,000 of water works bonds, and the collection of water rates by the city made the creation of this fund necessary.

In connection with the growth of the water system it is worth while to notice the growth of the city's population. In 1870 it was 1,107; in 1880, 3,533; in 1890, 42,837. Seattle was, therefore, a large city when it secured possession of a municipal water plant. The above population does not include the suburbs, which had not at that time been incorporated with the city, and which had perhaps not less than 10,000 people.

At the close of the year 1890 the City Comptroller reported the receipts into the water fund for the year as follows:

Sale of bonds	$450,000.00
Receipts from plant	16,892.75
Taxes	178.06
	$467,070.81

The city began collecting water rates and turning the money into the water fund in November, 1890, so that the above collections represent the receipts for a period of two months only. Previous to this date, however, and while the Spring Hill Company owned the system, a special tax levy was made to pay for fire protection, and the proceeds of this levy was kept on the city books under the designation of Water Fund. In the report of the city clerk for the year ending May 31, 1889, the water fund receipts are stated to be $3,255.40.

The disbursements for 1890 were reported by the comptroller as follows:

Superintendent	$ 266.66
Office	1,403.27
Pumping Station	4,535.91
Operating	677.27
Construction	82,398.77
Spring Hill Water Co	355,898.80
Fire Boat	11,889.50
	$457,070.18

F. H. Whitworth

THE CEDAR RIVER WATER SYSTEM

In the year 1881 Mr. F. H. Whitworth in a letter to the City Council suggested Cedar River as a source of supply for the city. In exploring for coal deposits, he had taken elevations across the divide between the Green River and Cedar River basins reaching Cedar River at a point just above the present intake at an elevation of between 500 and 600 feet above tidewater. He saw that both the elevation and the physical conformation of the valley at that point made possible the construction of a dam and intake and remarked to the men in his party that there was a good location for head works. Just 20 years passed from that time until the plant went into operation in the year 1901.

An amusing incident which happened at that time shows the vague ideas that many people entertained with reference to securing a water supply from Cedar River.

Mr. Whitworth had suggested that it would be necessary to go several miles up Cedar River from Renton in order to secure static head enough to raise the water into the city reservoirs.

A local engineer attacked this idea of Mr. Whitworth's, and declared that it was only necessary to build a wooden flume from the Cedar River at Renton to the reservoir on Beacon Hill, fit up a scoop-shaped arrangement at the receiving end of this flume, lower the scoop into Cedar River at Renton when the violent current of the river would force the water up the flume into the reservoir! Commenting on this proposal in the year 1913, Mr. R. H. Thomson said that many people took the statement seriously and Mr. Whitworth was roundly scored for proposing to waste public money by going further up the river.

Before Cedar River was fully settled upon as a source of supply public attention was centered on Rock Creek and the springs in the vicinity of its source. This creek has its source in Section 25, Township 22 North, Range 6, East of the Willamette Meridian, and flows about two miles northwesterly emptying into Cedar River near the Quarter Section Corner between Sections 22 and 23. The water in this stream was considered even purer and better than that in Cedar River, and Scurry's reconnaissance in 1889 was made with the view of determining the availability of Rock Creek as a source of supply.

On November 2, 1888, in accordance with the recommendation of the Fire and Water Committee, heretofore printed, Ordinance No. 1009 passed the City Council and was approved by Mayor Moran, pro-

viding for a special city election to decide whether the city should build a gravity water system from Rock Creek that would deliver about 10 million gallons of water per day, enough for 100,000 people, at an estimated cost of $1,000,000, and setting the time for the election as November 19, 1888. Before the next Council meeting, which took place a week later, Mayor Moran had discovered that an error in the ordinance calling the election made the call illegal, so the Council postponed the decision of the question by popular vote until the general city election, which took place on the second Monday in July, 1889.

The proposition to issue the bonds carried, but the bonds were never issued as under the State laws the amount was in excess of the debt limit.

It is interesting to go back to this election in July, 1889, and note the small vote that authorized the issue of $1,000,000 in bonds for this great project. The vote, cast as it was, only one month subsequent to the great fire of June 6, 1889, was almost unanimous in favor of the enterprise, but the aggregate vote cast was small. As canvassed by the City Council it stood as follows:

	In Favor	Against
First Ward	385	6
Second Ward	524	24
Third Ward	462	13
Fourth Ward	504	8
	1875	51

During the summer of 1889, Mayor Moran, as heretofore noted, entered into negotiations with Mr. Benezette Williams, a water works engineer of national reputation, and closed a contract with him for planning and superintending the construction of a system of water works for the City of Seattle. The contract was ratified by Ordinance No. 1247, approved November 23, 1889, eleven days after Mr. Williams had submitted his preliminary report to the Mayor and Common Council, the date of his report being November 12, 1889. As this and suubsequent reports made by Mr. Williams are among the most comprehensive and valuable documents ever issued in connection with the department, we print them in full.

PRELIMINARY REPORT BY BENEZETTE WILLIAMS

Seattle, November 12, 1889.

To the Mayor and Common Council,
Seattle, Washington.

Gentlemen:

In accordance with the instructions received from his Honor, and your Committee on Fire and Water, I have investigated the question of

a new water supply for the City of Seattle, and have made an estimate of the value, to the city, of the water works, belonging to the Spring Hill Water Company, which now furnishes the city with water.

As my instructions are to estimate the value of these works on the basis of their incorporation in the proposed new works—that is, to determine how much the cost of new works will be reduced by using such portions of the old ones as can be made an integral part of the new—it is necessary to take up the question of what the new works are to be, then to determine what parts of the old can be incorporated in them, and the value to the city of the parts thus incorporated.

I hence follow this order, and outline first the plan which I recommend and the reasons for such recommendations.

There were two methods of obtaining a permanent supply of water brought to my attention by your committee at the outset of this investigation. One was to continue on the lines of the Spring Hill Company's works and to obtain water by pumping it from Lake Washington. This would involve a mere enlargement and extension of the old works, or the building of entirely new works to be supplied by pumps from Lake Washington. Another was to obtain water from Rock Creek, a tributary to Cedar River above Maple Valley on the Columbia & Puget Sound Railroad. This involves an aqueduct or conduit to conduct the water to reservoirs in the city, the discharge being obtained by gravity, pumps only being used for such part of the city as may lie too high to be thus supplied from the proposed source.

It required but a cursory examination of the topographical and hydrographical surroundings of the city to convince me that there was no feasible alternative to the adoption in the main of one or the other of these methods.

In the two reports of the Fire and Water Committee made respectively October 18, 1888, and July 21, 1889, by which were transmitted estimates of the cost of obtaining water from Rock Creek made by the City Engineer, Mr. John G. Scurry, and an analysis of samples of water taken from Lake Washington and Rock Creek made by Prof. James Parkinson, the reasons why Lake Washington as a source of supply is objectionable and why a supply from Rock Creek is to be preferred, are made apparent. These are that Lake Washington water already bears considerable organic matter in solution, which amount is sure to increase in the future; and that a gravity system is to be preferred to one depending upon pumping.

The analysis of the water from Lake Washington shows 2.68 grains of organic matter per gallon, while that for the Rock Creek water shows but a trace. It should be said in this connection that the inorganic matter in Lake Washington water is given at 5.81 grains per gallon, while that for Rock Creek is but 4.20 grains. As the amounts of inorganic matter, are, in these cases a measure of the degree of hardness, it is seen that

so far as there is any preference on this account, the Rock Creek water is to be preferred.

An examination of the topography of the City of Seattle discloses the fact that much the largest part of its area has a natural drainage into Lake Washington, and that when sewerage systems are built, they will discharge the sewerage into the lake unless expensive pumping plants are used to throw it into the bay.

Then communities are growing up on the eastern shores of the lake, and there is a strong probability that the future will see it the fresh water harbor for Puget Sound shipping. With this, and even without it, manufacturing concerns of all descriptions will surely seek a home upon its shores. In fact, it may be safely assumed that the commercial development of Seattle and its vicinity, will surely add, year by year, to the contamination of the water of Lake Washington in spite of the utmost care that may be exercised to prevent it.

While any organic contamination of a domestic water supply is to be avoided, it should be borne in mind that the most danger to life and health arises from the facility with which the bacteria or germs of specific diseases can be, and are, frequently conveyed by the water furnished to a city. This is a most prolific way of propagating typhoid, and kindred diseases. It may occur with water which to taste and smell, and even to a chemical analysis, shows scarcely a trace of organic pollution.

Nothing can be more certain than that all human excrement should be excluded from the source of every domestic water supply, and as it is impossible to do this in the case of Lake Washington, some other way for supplying the City of Seattle should be found.

At the head of Rock Creek, and in the vicinity of the little lakes lying on the divide between the Cedar, and the White and Green Rivers, this side of Rock Creek, there will always be a rural population, very few in number. The ground throughout this region is a glacial drift, of a porous gravelly nature, which readily absorbs water, and watery substances. This combination of a sparse population, with a wooded country, and a porous soil, is such as to reduce to a minimum the chances for contamination of these sources of supply by human excrement; their contamination from other causes will be so slight that it may be ignored as of no practical consequence.

The sanitary facts may therefore be said to be wholly in favor of the Rock Creek and kindred sources of supply.

The physical facts have next to be considered, and first of these should come the quantity of water available; but before this can be intelligently discussed it will be necessary to outline the plan which is recommended as the one best adapted to the needs of your city.

Since I have begun this investigation, sufficient data has been collected to enable me to recommend that Rock Creek be relied upon as the principal source of supply, but that instead of piping the water direct to the city, that it be conducted into Swan Lake with such other water as

may come in the way, and that this lake be used as a head or impounding reservoir for the city water works.

Upon the accompanying map is shown Rock Creek, and Swan Lake, with other lakes situated upon the divide between Cedar River and White and Green Rivers. It also shows a line connecting Rock Creek and Swan Lake, and one leading from the lake to the city reservoirs, which represent approximately the route of the proposed aqueduct.

The elevation of Rock Creek at the bend in Section 26 is 556 feet, of Wilderness Lake 466 feet, of Pipe Lake 528 feet, of Spoon Lake about 500 and of Swan Lake 475 feet above high tide. These lakes have their outfall southward to Green River and are cut off from Cedar River by a ridge of variable height. The water from all of them (except that from Wilderness Lake), together with that from Rock Creek, may be gathered by one channel and conducted into Swan Lake. By this means they all become tributary to the city's water supply.

From Swan Lake it is proposed to feed two reservoirs having different elevations located within the city limits. The bottom of the reservoir of the Spring Hill Water Company has an elevation of about 300 feet above high tide. At or near the site of this reservoir it is not practicable to obtain a much greater elevation. If we allow for height of buildings, and loss of head in distributing mains, we cannot rely upon supplying any portion of the city above an elevation of 200 feet from a reservoir on or near this site.

Although the topographical survey of the city is unfinished, it is sufficiently complete to show that the greater part of its area lies above a 200 feet contour. But owing to nearly all of the business portion of the city being below this height, it is safe to assume that, in the future as in the present, the greater part of the water used by the city will be by the lower territory. Of the territory above 200 feet, by far the larger part lies below a level of 350 feet, though just what part, the surveys, owing to their incompleteness, do not show.

Above an elevation of 300 feet it is safe to assume that the buildings will be mainly dwellings or small stores, rarely if ever, more than two stories in height. If a reservoir is built with its bottom at an elevation of 400 feet, and its flow line at 420 feet, it will satisfactorily supply all the territory ranging from 200 to 350 feet above high tide, and in certain places, as, for instance, near to the reservoir, it may reach even higher than 350 feet.

The best location for such a reservoir is on the ridge crossed by Madison Street in Section 33 or 29. This is centrally located for the district to be supplied from it. Two such reservoirs with their bottoms 300 and 400 feet, respectively, above high tide, can be fed alternately by one conduit from Swan Lake. While the upper one is being filled, the connection between the lower one and the conduit would have to be shut off. The rate of discharge into the upper one would be about one half that into the lower one. So that if the high service system required half

the amount of water used by the low service system it would take equal times to supply the reservoir and the respective systems.

The plan of the water works proposed for the city will therefore be said to embrace a high service and a low service gravity system, each supplied through one conduit from Swan Lake, and a high service pumping system, supplied from the upper reservoir, for such portions of the city as cannot be reached by the high service gravity works. The supply being drawn mainly from Rock Creek through Swan Lake, though intermediate lakes, will contribute the amount they are capable of furnishing.

The distribution pipes for the two gravity systems should be connected through a valve at some suitable point, so that in case of fire, or other emergency, the pressure of the high service reservoir can be turned into the low service pipes.

The quanity of water required is dependent upon the growth of the city, and of course is problematical. A study of the rates of growth of numerous cities in the United States convinces me, however, that it is not safe nor advisable for you to proceed with the construction of works upon the plan proposed on a basis of less than 250,000 population, which will require fully 25,000,000 gallons of water in 24 hours. One quarter of this amount will doubtless be used by the time the works shall have been fairly put into operation.

Owing to the lakes being low, following the dry season, and to other causes, it is now impossible to measure with exactness the amount of water that can be obtained from the proposed sources. By the plan proposed the surplus water of the wet season will be impounded in Swan Lake, which has an area of perhaps 600 acres, and thereby largely augment the dry weather supply.

Mr. Scurry's measurements show nearly enough water in Rock Creek alone to meet the requirements, and without doubt the additional amount—and probably more—may be obtained from the lakes which it is proposed to take into the system.

In carrying out a work of the magnitude proposed, for a city occupying so commanding a commercial position as does Seattle, and surrounded by such wonderful natural resources—which are as yet undeveloped—it would not be wise to look for a city of but 250,000 people, and the amount of water necessary only for such a population. A reserve supply should be sought out, which, if possible, should be capable of being utilized in harmony with the proposed works. Such a reservoir is said to exist in Little Cedar River which enters Cedar River a few miles above Rock Creek.

Before entering finally upon the connstruction of the proposed works, a preliminary survey of this source should be made, and the head works so planned that if possible water from this river may in the future be conducted into Swan Lake without any radical remodeling of the works.

Aqueducts

It is too soon to attempt to give in detail the kind and size of conduits to be used in impounding the water in Swan Lake and in conveying it from there to the city. So much depends upon the topography of the route—which has as yet been only partially ascertained—upon the pressure to be sustained at different points, and upon the cost of different kinds of construction and materials, and upon the safety and durability of the same, that any statement made now covering the ground would probably have to be greatly modified. In a general way it may be said that if Swan Lake is used as a storage reservoir, it will be capable of furnishing a seventy days' supply of 25,000,000 gallons without receiving accessions from the outside; and that hence it will be safer to conduct the water from Rock Creek to the lake by means of an open channel wherever the hydraulic grade can be held, which will probably be for the whole distance of about six miles, except for about 3,300 feet, where a pressure pipe will be necessary.

From the head of Swan Lake to a point on Rock Creek from which water may be drawn, by any line which it will be practicable to follow, is fully seven and one-half miles. By the utilization of natural channels including the lake itself where it can be done, and the use of open ditches as proposed, the cost of this seven and one-half miles will be reduced to less than one half of the cost of a pressure pipe.

From Swan Lake to the top of the hill southeast of Renton a grade conduit of masonry or a pressure pipe may be used, according as the profile of the line is found to be favorable to one or to the other. From this point to the reservoirs a pressure pipe will be necessary.

Capacity of Distributing Reservoirs

To be prepared for a possible accident to the pipe line between Swan Lake and the city reservoirs they should hold sufficient water for a three days' supply; or say, 50,000,000 gallons capacity for the low service reservoir, and 25,000,000 gallons for the high service reservoir. Should the Spring Hill Water Works come into possession of the city it will not be necessary to build a new low service reservoir at first, as the old reservoir which holds about 4,500,000 gallons can be made to answer for some years, if the high service one with a capacity of 25,000,000 gallons is built in the beginning.

In case of an emergency the low service reservoir can be filled from the high service one, and 29,500,000 gallons storage capacity will answer for several days after the works are put into operation.

Comparative Cost of a Pumping and Gravity Supply

If we assume that one-third of the water used by the city will pass through the high service reservoir at an elevation of 420 feet, and that two-thirds will pass through the low service one with an elevation of 320 feet, then the average height to which all the water will have to be

raised to attain these elevations is 353 feet above high tide, or 335 feet above the level of Lake Washington. If to this we add 35 feet for friction head we have 370 feet as the equivalent of the pressure under which pumps stationed at Lake Washington would have to work to supply the city.

The cost of pumping 5,000,000 gallons per day, for 365 days, to this height, with the best pumping machinery based upon the lowest Chicago cost of pumping, viz.: Six cents for 1,000,000 gallons raised one foot high is $40,515.00, which is equal to the interest for one year at five per cent on $810,300.00.

That is, if a gravity system were to cost $810,300.00 more than a pumping system, the saving in the operation of the works when 5,000,000 gallons of water was being used per day, would pay the interest on the difference of cost; and when 25,000,000 gallons was used, it would pay this interest, and effect a saving of $162,000.00 per annum.

Although the surveys and plans are not sufficiently matured to enable a close comparative estimate to be made, between the cost of a pumping system and that of the gravity system proposed, yet it can be stated positively that the difference will not reach any such sum as that named. Indeed, it is not likely to exceed $600,000.

As soon as new works are put into operation, with adequate distribution pipes reaching all inhabited parts of the city, the use of water will hardly be less than 5,000,000 gallons per day, so that it may be safely assumed that from the beginning the saving in annual expenditure of gravity works will more than pay the interest on the difference of cost between these and the pumping works.

It is thus seen that both from a sanitary and economical point of view, the gravity system proposed is greatly to be preferred to a Lake Washington supply with a pumping system.

For the reasons which have already been stated, viz.: the lack of sufficient data, I have not ventured to give an estimate of the cost of the works as described. In general it may be said that they will probably not greatly differ in cost from the estimate previously made by the city engineer. Their capacity being more than double that formerly proposed, it will necessarily be some greater.

Value of the Spring Hill Water Works

As previously stated the estimate of the value of these works is based solely upon what it would cost to duplicate those portions of the works which can be made a part of the completed gravity system that has been recommended. In a pumping system such as the Spring Hill Works there has necessarily been a large expense incurred from time to time, which will represent but little value when used to splice out new works of an entirely different character and greater capacity. For this reason the following estimate does not pretend to represent the original cost of these works, nor indeed what it would cost to duplicate them, but

only what it would cost to substitute new parts for the old parts, which it is practicable to incorporate in the proposed new works. The value of the real estate upon which the pump house and reservoir stands has been omitted.

Estimate of Spring Hill Water Works

One reservoir of 4,500,000 gal. capacity	$ 22,500.00
15,500 lin. ft. of 12 in. pipe @ $2.10	32,550.00
1,200 lin. ft. of 10 in. pipe @ $1.64	1,968.00
24,310 lin. ft. of 8 in. pipe @ $1.20	29,172.00
16,400 lin. ft. of 6 in. pipe @ 88c.	14,432.00
4,000 lin. ft. of 4 in. pipe @ 60c	2,400.00
Stop valves on mains, say	2,000.00
Three boilers, 54 in. x 16 ft.	3,000.00
One boiler 42 in. x 14 ft.	800.00
One pump of 1,500,000 gal. capacity	6 500.00
One pump of 750,000 gal. capacity	1,500.00
One pump of 300,000 gal. capacity	850.00
Miscellaneous items about pumping works, pipes, valves, gauges, fire tools, etc., say	1,500.00
	$119,172.00

In the above estimate I have not included any pipe smaller than four inches nor any of that not connected with the reservoir which leads from the springs on the bluff. I have included, however, the 12 inch force main from the pumping works to the reservoir, and the 12 inch supply main leading from the reservoir to the city, although the latter in some cases runs across private property and will presumably have to be removed.

There are in use some 75,000 feet of 2 and 2½ inch pipe, which is not included. I have included all the pumps and boilers, although it is questionable in the absence of well matured detailed plans, whether all of these will ever be wanted by the city for high pressure pumping or not. The lengths of pipe have been partly taken by scale from a distribution plan furnished by the Spring Hill Company and partly from other data furnished by them. At the best the amount given can only be approximate.

The pipe used in the Spring Hill Water Works is nearly all made of light wrought iron, and the diameters given are outside measurements. Such pipe if perfectly protected, so as to prevent corrosion, will be durable, otherwise they are liable to fail in the course of years. As to the condition of these pipe I have no way of judging except by the examination of pieces which have been removed since the fire. These indicate a good state of preservation.

The pumps and boilers do not show superficially their present condition, but I am assured by the manager of the works, that these too are sound and in good condition.

The reservoir may be considered good.

Respectfully submitted,

BENEZETTE WILLIAMS,

Chief Engineer.

BENEZETTE WILLIAMS

Report to the Mayor and City Council of Seattle, Washington, on Water Works for the City

By BENEZETTE WILLIAMS
Chief Engineer

To the Honorable the Mayor and Common Council,
Seattle, Washington:

Gentlemen:

In my report of November 12, 1889, I had the honor to outline to you a plan for new water works for the City of Seattle. In doing this I made no attempt to go into details of construction or of cost. In that report I endeavored to give briefly the sanitary reasons why Lake Washington should not be permanently relied upon as a source of water supply, and why, both from an economical and sanitary point of view, a gravity supply, drawn from Rock Creek and kindred sources, is greatly to be preferred.

It was then proposed that "instead of piping the water direct to the city, it be conducted into Swan Lake, with such other water as may come in the way, and that this lake be used as a head or impounding reservoir for the city water works."

From Swan Lake it was proposed to feed alternately, by one conduit, two reservoirs within the city limits, their bottoms having an elevation of 300 feet and 400 feet, respectively, above high tide. It was then stated that, "although the topographical survey of the city is unfinished, it is sufficiently complete to show that the greater part of the area of the city lies above a 200-foot contour. But owing to nearly all of the business portion of the city being below this height it is safe to assume that in the future, as in the present, the greater part of the water used by the city will be by the lower territory. Of the territory above 200 feet, by far the larger part lies below a level of 350 feet." It was proposed to supply territory above the 350 feet level by means of pumping.

In the language of the report, "The plan of water works proposed for the city, may, therefore, be said to embrace a high service and a low service gravity system, each supplied through one conduit from Swan Lake, and a high service pumping system, supplied from the upper reservoir, for such portions of the city as cannot be reached by the high service gravity works; the supply being drawn mainly from Rock Creek, through Swan Lake, though intermediate lakes will contribute the amount they are capable of furnishing."

It was further stated that it was then impossible to tell how much water could be obtained from the sources named, and that, in carrying out a work of the magnitude proposed, it would not be wise to look only for the amount of water needed for a city of 250,000 people; but that a reserve supply should be sought out, which could be utilized in harmony with the proposed work; and that such a supply was said to exist in Little Cedar River. It was recommended that a preliminary survey of this source should be made, and the head works so planned that water therefrom could be conducted into Swan Lake without a radical remodeling of the same.

At the time this report was written, preliminary surveys had merely gone far enough to establish the relative heights of Swan Lake, Rock Creek, and other lakes lying on the divide between Cedar and Green Rivers, and the feasibility of making Swan Lake a storage reservoir. It had not been possible for me to secure a measurement of the flow of water in Rock Creek.

Since then careful preliminary surveys have been made by the City Engineer for a pipe line from the city to Swan Lake, and for a flume line from Swan Lake to Rock Creek, and thence to Cedar River. These surveys have been thoroughly made and full topographical notes taken. Topographical surveys of the city have also been carried on, and are now sufficiently complete to enable the distribution systems to be properly planned.

I also had a gauging of the flow of water in Rock Creek made, which demonstrated that it would not do to rely upon that stream to supply the amount of water needed for works of the capacity of those proposed.

The first preliminary line run to determine the distance to, and the elevation of, Little Cedar River, developed the fact that by going 13,000 feet, or about 2½ miles, greater distance than the distance to Rock Creek, the main Cedar River has a sufficient elevation to admit of water being taken therefrom. As the flow of Cedar River seemed more than ample for any possible needs of the city, careful surveys were at once made to determine the most feasible line for a flume from that river to Swan Lake. The survey of this line, of the eastern extremity of Swan Lake, and of a portion of the Cedar River Valley completed the preliminary work from Seattle to Cedar River.

Owing to the inaccessibility of the timber region through which the route lies for the most of the way, and the broken character of the country, the matter of finding the best line for an aqueduct would have been tedious and difficult under the best auspices, but the extremely bad weather that has prevailed most of the time has greatly added to the difficulty. It has been necessary beyond Black River to run numerous lines, in order to develop the topography sufficiently to enable the best location to be made.

PRESENT PLAN

The plan now proposed for waterworks for the City of Seattle, is the same as that outlined in my previous report, except as to the source of the water supply, and may be described as follows:

On Cedar River, about 900 feet above the east line of Section 24, Township 22 North, of Range 6, East of the Willamette Meridian, where the river has a low water elevation of 513 feet above high tide, it is proposed to build a timber and earthen dam across the river and the river valley, which will raise the water surface so as to flow over a dam 21 feet above low water, having an elevation of 534 feet above high tide.

From this point a V-shaped flume, having a fall of 1 in 1,000, is to conduct the water for a distance of 23,400 feet, to a point near the Columbia & Puget Sound Railway, one mile above Maple Valley Station. Thence a 48-inch pipe is to be used for a distance of 4,000 feet, across the valley through which the railroad runs, having an average fall of 2.5 in 1,000. Thence the V-shaped flume is used as before for a distance of 14,400 feet, to a point in Section 6, Township 22, Range 6, distant 6,000 feet from the present eastern extremity of Swan Lake, and 41,800 feet from the Cedar River dam.

At this point the bottom of the flume will have an elevation of 482 feet above high tide, and the flume will discharge into a trough-shaped valley leading to the lake.

The flume for about 1,700 feet of the way will be elevated from 40 to 60 feet above the ground, in order to cross Cedar River bottom and the Rock Creek Canyon. The remainder of the way it will be in earth.

The present low water level of Swan Lake is 468 feet above high tide, and it is proposed to dam its outlet so as to raise the level of the water to 485 feet above high tide. This will have the effect of extending the eastern arm of the lake to the mouth of the flume.

On the western shore of Swan Lake, near its north end, at a point distant about 13,000 feet from the mouth of the flume, an inlet crib, with a head-gate, is to be built, connecting with a tunnel that it is proposed to make through the ridge skirting the lake on the northwest.

The inlet is to be so placed that there will be an available depth of 16 feet of water above it when the lake is filled to the proposed height of 485 feet above high tide.

From the inlet crib the tunnel is to have a fall of 1 in 1,000, and is to terminate in a shaft located at about the center of the southeast quarter of Section 34, Township 23 North, Range 5, East of the Willamette Meridian, and distant about 5,300 feet from the lake inlet. Near the top of this shaft is to be a waste weir, which will allow the lake to overflow through the tunnel when it gets higher than the fixed elevation. This overflow will discharge into a natural drainage channel leading back into Cedar River.

From the bottom of the weir shaft it is proposed to conduct the water through a pipe 42 inches in diameter to the city reservoirs. The pipe will be under pressure for its whole distance.

The proposed line of the pipe follows a very direct course, crossing Black River a short distance below the highway bridge at Renton; thence along the ridge to the old reservoir, where a branch will connect with the same, being a total distance from the end of the tunnel of 74,400 feet, approximately.

From this reservoir it is proposed to follow Fourteenth Street, Broadway and other streets to the proposed site of the high service reservoir in the northeast quarter of the northeast quarter of Section 29—the property known as the City Park—making a total distance from the end of the tunnel of 92,800 feet.

The approximate lengths of the different kinds of aqueducts proposed may be summarized as follows:

	Feet
V-shaped flume in earth	36,100
V-shaped flume elevated	1,700
48-inch pipe	4,000
Bed of Swan Lake	13,000
Tunnel at Swan Lake	5,300
42-inch pipe	92,800
Total	152,900

or about twenty-nine miles, which is approximately the distance that water will have to traverse to reach the high service reservoir from the dam on Cedar River.

CEDAR RIVER

Cedar River, from which it is proposed to take the water to be supplied to the city, is a clear stream, running over a gravel and boulder bottom, and having its source in the Cascade Mountains. Its bed varies in width from 100 to 150 feet. The distance from the site of the proposed dam to its confluence with Black River, at Renton, following the sinuosities of the stream, is about 1·9 miles. The total slope of the river in that distance is 494 feet, or an average of 26 feet to the mile.

There are no settlements on the river above Maple Valley, which is six miles below the proposed dam.

There has been no opportunity for a careful hydrographic survey of the river, but such as came incidentally in the course of the preliminary work.

From the cross sections of the river bed, the slope of the stream, and the height of water at different stages of the river, I estimate that on December 21, 1889, before the snows began to melt, and when the river may be considered as being not much above its low-water stage, the flow was 115,000,000 gallons in 24 hours. During February, while the snows were melting, one stage showed 675,000,000 gallons, and some days later,

at still another stage of the river, probably near the high-water stage, the estimate gives 1,500,000,000 gallons in 24 hours. These estimates are rough, and should only be used to indicate the fact that the amount of water that can be furnished by the river, used in connection with Swan Lake as a storage reservoir, will be ample for all possible demands that the city can make upon it.

The water is clear at all ordinary stages, and no more discolored than other mountain streams during freshets.

No analysis has been made of the water, but, judging from the character of the country from which it comes, it may be assumed that it will not differ greatly from that shown for the Rock Creek water.

SWAN LAKE

Swan Lake is a clear, deep lake, with gravel bottom, and generally with steep, precipitous shores, comparatively free of all vegetable growth, except that for a short distance around the northwestern part of the lake the shores are not so steep, and some bulrushes grow.

Though having its outlet into Green River, many miles south, it lies within less than two and one-half miles of Cedar River, and within one-third of a mile of the divide between the two rivers.

Several clearings have been made on its shores, and some half-dozen cheap houses built; all but one or two of which, however, are above the proposed level of the water.

Surveys have not been made to determine the area of the lake, though, roughly estimated by the map, it is about 600 acres. After being raised to a level of 485 feet above high tide, its area will probably be about 800 acres. There will then be an average of 700 acres, with a depth of 16 feet, as a supply that can be drawn upon without replenishing from Cedar River. This is equivalent to about five months' supply of 25,000,000 gallons each 24 hours.

There are numerous advantages to be derived from this use of Swan Lake as a reservoir, some of which may be briefly stated:

First: It is economical to use it. The total estimated cost of all the work, from the Cedar River dam to the end of the tunnel in Section 34, exclusive of realty, is $280,686, and the approximate total distance is 60,100 feet. This gives an average of $4.67 per lineal foot.

The line of flumes and tunnels, as designed for this distance, has a capacity to deliver at the end of the tunnel in Section 34, 50,000,000 gallons in 24 hours, or double the amount that a 42 inch pipe can carry from there to the city, under the conditions which it will work. A pipe to do the work, with a total fall of 55 feet between the Cedar River dam and the end of the tunnel, that a 42 inch pipe will do from there to the city, would have to be 52 inches in diameter, and would cost, including the dam, grubbing, clearing and grading, at least $135,000 more than the line of flumes and tunnel and lake improvement as proposed.

Second: The use of Swan Lake eliminates elements of hazard to the water supply, in that it practically brings the source nearly twelve miles nearer to the city, and substitutes a large reservoir, that is not subject to accident, for a small one, that is. There would be ample time to rebuild the Cedar River dam entire, without leaving the city short of water, should the dam go out, or need rebuilding because of decay, without diminishing the city's supply of water.

Third: Should the city wish to increase the water supply, it will only need to lay another pipe from the end of the tunnel to the low service reservoir, using the pipe at present proposed entirely for the high service supply. This, indeed, would be the ideal system, as it would not leave the city dependent upon one pipe, and would obviate the necessity of alternating the use of the pipe between the two services.

The advantages of raising the surface of Swan Lake are, that it gives an additional head, which will increase the discharge into the city reservoirs, particularly into the high service one; and that it also increases the capacity of the lake, and renders it feasible to build the inlet crib and lake end of the tunnel without working under water.

RESERVOIRS

The available capacity of the proposed high service reservoir is 26,412,188 gallons.

Its bottom is to be 400 feet, the top of the coping 425½ feet, and its flow line 422½ feet above high tide.

The ground on the proposed site, so far as investigations have shown, is porous and without any suitable material to make a puddle wall, though it is excellent material for a solid, unyielding bank. The plan of construction proposed depends upon the pavement to secure water-tightness. This pavement is a combination of wood, asphaltum and brick, so laid as to be at once impervious and unyielding, the wood being so protected and placed as to be free from danger of decay.

The total estimated cost of this reservoir is $106,641.65, or $4,-037.60 per million gallons of available capacity; that is, the amount of water which it will hold between the point of overflow and a level of 2½ feet above the bottom.

In the preliminary report, it was stated that should the city acquire the Spring Hill Water Works, the building of the low service reservoir therein recommended can be deferred for a few years. I have proceeded on this theory, and have hence made no detail plans for such a reservoir, intending that the old reservoir shall be made to serve the ends of the city for a time. I would recommend, however, that the site be acquired at the same time that ground for right of way, etc., is procured.

Since one pipe from Swan Lake is to supply both reservoirs, some arrangement will have to be made by which the operation of turning the water on and off the two reservoirs alternately, can be controlled from

one point. To do this, I propose that the necessary valves be placed at the low service reservoir, properly arranged in a comfortable house, where an operator can be stationed.

As the high service reservoir is more than three miles distant from the low service one, some means must be adopted to keep the operator informed of the stage of the water in that reservoir. Probably the simplest way to do this is to lay a small pipe, say one inch in diameter, in the same trench with the supply main connecting the high service reservoir with the valve house, and have the head of water in the reservoir balanced by a mercury column which, by means of a gauge, will indicate at all times the exact height of water in the upper reservoir.

MAIN SUPPLY PIPE

As before stated, the main pipe that is intended to reach from the end of the tunnel, in Section 34, to the city reservoir, will be, approximately, 92,800 feet long, and is to have an inside diameter of 42 inches. The pressure to be borne by the pipe varies from 20 to 210 pounds per square inch. It is proposed that this pipe be made of 3-inch wooden staves, securely banded with wrought iron or steel bands, the bands being joined with bolts which will admit of any desired strain being brought upon them in the laying. They can be adjusted to suit the head at every part of the pipe by varying their size and distance from each other. It is proposed to coat the outer surface of the staves and the iron bands, by dipping them in a kettle of hot asphaltum before they go into the work; and again, before the pipe is finally covered up in the trench, the outer surface of the bands and staves are to have another coat applied with a brush. The effect of this will be to make an impervious, unbroken coating, which will exclude the air and prevent evaporation of the moisture which penetrates the pores of the wood from the inside, and thus preserve the surface of the staves from decay, without regard to the character of the ground in which the pipe may be laid. The inner portion of the staves cannot decay, under any conditions, while the pipe is in use.

Manholes, blow-offs, and air-valves are provided for, and connections for lateral pipes within the city.

The crossing of Black River is to be with a section of pipe, made of 7-16 inch steel plate, placed in a trench dredged below the river bottom.

In the valve house, at the low service reservoir, a valve is to be placed upon the pipe, by means of which the water can be shut off from the high service reservoir. When this valve is closed, as at all times, the pipe between it and the high service reservoir will serve as a supply main for the high-level district.

The pipe is to be laid three feet underground.

Wherever necessary, the pipe line is to be cleared, and grubbed, and graded before the pipe is laid.

The cost of this pipe, not including the preparation of the line, is estimated at $7.50 per foot.

The cost of cast iron pipe of the proper weight—an average of 575 pounds per foot—and the same size as the proposed wooden pipe, I estimate would be $15.00 per lineal foot; and that of a steel-riveted pipe, made of plate from 3-16 inch to 7-16 inch thick, according to pressure, at $10.00 per lineal foot, taking a like basis for labor and material in each case.

It is claimed by the makers, that what is known as Bayles' flange-ribbed sectional pipe, can be made of equal strength, cheaper than any other kind of iron pipe, because it is easier to put together, and material is used in a more economical manner. As I have no data by which to estimate the probable cost of this pipe, no attempt is made to compare it with the other kinds, except to say that if it can be furnished cheap enough, it will be well adapted for the work.

The distance from Swan Lake to the valve house at the low service reservoir is about 15 miles, and throughout the whole distance, while the pipe is in use, there is a moving column of water. Each time that a valve is closed at the valve house, the movement of the water must be arrested. If this is done with sufficient slowness, the moving column will be brought to rest without perceptible shock; but if it is done too quickly, the pipe will be unduly strained. There are two possible ways of removing the danger from this. One is by means of a stand-pipe, reaching to the height of Swan Lake, which will overflow, and thus relieve the pipe; another is to put one or more relief valves on the pipe, which will allow water to escape when the pressure is too high. This matter has been deferred for future consideration.

FLUME

The approximate length of the open V-shaped flume proposed between Cedar River dam and Swan Lake, is given at 37,800 feet, of which about 1,700 feet is to be carried on timber bents and cantilever trusses. The trusses are to be used at two crossings of Cedar River. The timber bents are to be used across a bend of the river valley; and at Rock Creek, which lies in a deep, narrow gorge, it is necessary to cross the valley about 6,000 feet below the dam, in order to avoid the passage of steep, high bluffs along the south bank of the river.

The flume is to be lined on the sides throughout with 2-inch plank, that have been dressed, matched and rabbeted, and coated with asphaltum. In laying, the joints are to be made tight with asphaltum, and their exposed surface recoated with asphaltum, applied with a brush. The bottom is to be lined with asphaltum concrete.

The area of the cross section of the timber lining where the flume is elevated will be 27 square feet, and in earth, 24 square feet, and banks of earth will rise one foot higher on either side.

It is believed that the lining so made will be permanently durable below the water line, and will last well above. It being coated with asphaltum will avoid surface decay, and do away with objections raised on that ground.

The proposed route for the flume is direct, and free of precipitate banks or extensive excavation.

CEDAR RIVER DAM

The Cedar River dam, as proposed, is to have a width of 150 feet, and to have its crest 534 feet above high tide ,and about 24 feet above the river bottom. It is to be a timber crib, arched between two timber-crib abutments. The cribs are to be filled with earth and the dam banked with earth on the upper side. On the north side of the river, across the valley, an earthen dam is to be built between the abutment and the bluffs—a distance of about 150 feet. All timber used in the dam that is not in a position to keep satuarated with water is to be cedar.

SWAN LAKE TUNNEL AND INLET

The approximate total length of Swan Lake tunnel is 5,300 feet from the inlet shaft to the weir shaft, and will have a net cross section of 22 square feet. Its bottom at the weir shaft is to have an elevation ot 460 feet above high tide, and is to rise with a grade of 1 in 1,000 to the inlet shaft.

The material through which the tunnel is to be dug is a gravelly drift, to all surface appearances, though presumably hard pan and cemented gravel will be encountered more or less.

It is to be walled solidly with sawed timbers, set in an inclined position, somewhat in the shape of an inverted V.

The bottom is to be lined with concrete, and the sides with matched plank.

The timbers, being always saturated with water, will not decay.

The inlet crib is to be made of timber from the bottom to a height of 14 feet, the top portion to be of concrete. It is to be divided into two chambers, with an iron gate between, by means of which the water can be entirely shut off from the tunnel and access had through the chamber. A screen is provided between the outer chamber and the lake. A gate house is to be built on the crib, in which the gearing for operating the gate is to be situated. A foot bridge will make the gate house accessible from the shore.

A timber and concrete shaft is to be located at the northwestern end of the tunnel, from which the 42 inch supply pipe will lead off. At the top of this shaft will be a weir, at a height of 484 feet above high tide, by which the surplus water brought into the lake from Cedar River will be wasted into a natural drainage channel and carried back into Cedar River.

COST OF GRAVITY SUPPLY

As may be seen by reference to the detail estimates given in Appendix A of this report, the total estimated cost of the works necessary to bringing the water into the city and storing it—that is, including the aqueducts, dams and reservoir, without realty or right-of-way—amounts to $1,200,793.65, which is divided as follows:

Reservoir in Section 29	$ 106,641.65
Main supply pipe, with attachments and connections, including the preparation of line	813,466.00
Aqueducts and other improvements from end of tunnel, in Section 34, to Cedar River dam, inclusive	280,686.00
Total	$1,200,793.65

If the main supply pipe is used 12 hours a day discharging into the high service reservoir—the total difference of elevation between the water in the reservoir and the water in the tunnel in Section 34, being 60 feet—and 12 hours in discharging into the low service reservoir—the difference in level being 160—it will supply each 24 hours the following amounts of water:

	Gallons
Into high service reservoir	9,000,000
Into low service reservoir	16,000,000
Total	25,000,000

If another main, 42 inches in diameter, were laid from the end of the tunnel to the low service reservoir, and used to constantly serve that reservoir, while the main now proposed were used exclusively for the high service reservoir, the two mains with the system as planned, would furnish for the high service 18,000,000 gallons, and for low service 32,000,000 gallons per diem, making a total of 50,000,000 gallons per diem. Such an additional pipe, with a new low service reservoir, holding 50,000,000 gallons, would cost for pipe, approximately, $558,000, and for the reservoir, approximately, $175,000, which, added to the estimated cost of the work now proposed, will amount in all to $1,933,793.65. That is, the city can, under the system proposed, increase its supply so as to have a total of 50,000,000 gallons of water per diem delivered into two storage reservoirs within the city for a total expenditure, including the reservoirs, but not including real estate, of $1,933,793.65, approximately. Considering that this water has to be conducted a distance of 26 miles to the low service reservoir, 320 feet above high tide, and 29 miles to the high service reservoir, 420 feet above high tide, through a rough, broken country, heavily timbered, with a pressure on the pipes in some places of 210 pounds per square inch, this may be said to be an unusually moderate cost.

COST OF GRAVITY AND PUMPING SYSTEMS COMPARED

In the preliminary report I pointed out that to pump 5,000,000 gallons per day from Lake Washington, to the average height required, at the rate of six cents per million gallons one foot high, would equal in cost the interest, at 5 per cent on $810,000, and that the cost of pumping 25,000,000 gallons per day would exceed the interest on this sum by $162,000 per annum.* It was also pointed out that, though no close comparative estimate could then be made of the difference in cost between a gravity system and a pumping system at Lake Washington, of equal capacity, that it would not be as much as $810,000, and that it would not be likely to exceed $600,000. It was also stated that it may be safely assumed that from the beginning the saving in annual expenditure, by gravity works, will more than pay the interest on the difference of cost between these and pumping works.

I am now enabled to make a comparison between gravity works and pumping works, as follows:

If pumping works were built on Lake Washington, at the foot of Yesler Avenue, with high duty pumps of a capacity to pump regularly each 24 hours 9,000,000 gallons of water into the high service reservoir, and 16,000,000 gallons into the low service reservoir, with buildings, force mains, inlets, one reservoir as proposed, pumps, and boilers complete, I estimate that they would cost, without a low service reservoir, $685,000, as against $1,200,793.65, the estimated cost of the proposed gravity works, giving a difference to $515,793.65 as the excess of the cost of gravity works, as proposed, over pumping works capable of rendering the same service. The interest on this sum, at 5 per cent amounts to $25,789.68 per annum.

To pump 9,000,000 gallons per day into the high service reservoir, through a 24-inch main—the size used in the estimates—the water would have to be lifted, including friction head, 470 feet, which work is the equivalent of 4,230,000,000 gallons lifted one foot high.

To pump 16,000,000 gallons per day into the low service reservoir, through a 30-inch main, the water would have to be lifted, including friction head, 350 feet, which work is the equivalent of 5,600,000,000 gallons lifted one foot high, making in all 9,830,000,000 gallons per day, lifted one foot high.

At six cents per million gallons, lifted one foot high, this amounts to $589.80 per day, or $215,277 per annum, as against $25,789.68 per annum, the interest, at 5 per cent, on the difference in cost between the gravity system, as proposed, and a pumping system at Lake Washington, which will do the same work.

To state the same proposition in different form:

If the estimated cost of pumping—$215,277 per annum—be capitalized at 5 per cent, it will represent an outlay of $4,305,540. That is, if gravity works were to cost this amount more than pumping

works, they would still be as economical as the latter, when 25,000,000 gallons of water per day is being used.

If we should base a like comparison on the amount of water—not less than one-third of 25,000,000 gallons which will be likely to be used by the end of the first year after the works are put into operation, it would show that if gravity works were to cost $1,435,180 more than pumping works, the saving in the expense of operation would pay the interest at 5 per cent on this amount.

A similar comparison made on the works enlarged to supply 50,000,000 gallons per day—as can be readily done—would be still more favorable to the gravity system.

The irresistible conclusion to be drawn from these figures is that it would be better for the city to incur a much larger debt than will be necessary to carry out the gravity system, rather than to adopt a pumping system, even if the water to be had in the two cases would always be equally pure.

QUANTITIES

As it is impossible to tell the exact amount of earth excavation until a line is finally located in all its details, and cross sectioned, the quantity of earth excavation given can only be considered approximate. The same should be said with reference to the clearing, for the reason that the borders of Swan Lake have not been surveyed so as to determine the area that will have to be cleared. With these two exceptions, the quantities given may be considered a sufficiently close approximation to the truth.

DURABILITY OF WOODEN CONSTRUCTION

It is a well established fact, that sound wood immersed in water, or in a permanently water-soaked ground, or in damp, impervious clay, is free from decay.

It has also been demonstrated in cities where wooden pavements have been laid on plank foundations, and the plank kept fairly well excluded from the air, that the plank does not rot. There are many old plank foundations in Chicago of pavements laid previous to 1871, which, after the fire, were covered, by a change of grade of the street, to a depth of perhaps two feet, that are as sound today as when first laid.

It is not uncommon in the central part of the city, where the ground was originally but a few feet above the lake, and where the street has been raised from time to time, to cut through three or four layers of plank, in digging trenches, at as many different depths, all of them sound. These planks are almost universally white pine or hemlock.

Decay in wood is caused by the fermentation of its sap, through the agency of bacterial life. This fermentation only occurs in the presence of both air and water. By the exclusion of either one, and the presence of the other, the wood is preserved.

By the accomplishment of this in the manner described, it is expected to preserve the wood used in the pavement for the reservoir, in the wooden pipe and in the flumes below the water line; and in all cases, as the tunnel, the cribs, and in Cedar River dam, where submerged in water or kept water-soaked.

In cases where wood is not permanently preserved, it can be replaced from time to time, or by some other class of structure in the future, better than to go to the expense of such structure now.

CONTAMINATION OF WATER

As has heretofore been pointed out, there are no settlements on Cedar River above the point where it is proposed to take water, and the few houses in the vicinity of Swan Lake could have little effect, so far as the amount of organic impurities go.

By the city acquiring a strip of land on the shores of the lake, they can put into effect any sanitary regulation necessary to prevent contamination from all animal matter and excretions.

Contamination by vegetable organic matter it is impossible to prevent in a country covered with a dense growth of vegetation, and a network of decaying logs. This, under ordinary conditions, may be assumed to be unimportant—at any rate, it is unavoidable.

It can only be by the propagation of some form of plant life in the reservoirs, such as certain varieties of fresh water *Algae*, and their subsequent death and decay, that a detrimental contamination can originate. This seldom if ever occurs in running streams, and never where sunlight is excluded, and hence cannot occur in the main supply pipe or tunnel. The conditions necessary to a growth of the varieties of *Algae* most objectionable are sunlight, and a temperature of water of about 70 degrees.

A reservoir fed with a mountain stream is much less productive of vegetable growth than if it is fed with water from the earth. A deep reservoir is much less liable to it than a shallow one. The considerable depth of the city reservoir, the great depth of Swan Lake, and the character of the stream from which the water comes, in a climate not subject to high extremes of heat, seem likely to prevent the occurrence of the proper temperature, and other conditions necessary to the propagation of the objectionable varieties of *Algae* in sufficient quantities to be detrimental.

Certain forms of *Algae* grow in almost every reservoir or stream, or other body of water. They are greenish in color, and thread-like in structure, and may be seen floating about in the water, often in tangled masses, or attached to rock, stones, wood, and other substances. Vegetable organisms of this variety are not harmful.

There are still other smaller varieties that float about in almost all surface water, that have no detrimental sanitary effect on water. It is only particular forms of vegetable life that propagate sometimes, but by no means generally, under the conditions of light and temperature mentioned, that, in sufficient quantities, are liable to produce injurious effects. They

come, if at all, only when the conditions are just right, and for a short time while such conditions obtain. There is no remedy for them but to cover the reservoir in which they propagate, or to keep the temperature too low for them to live.

There is no more reason to apprehend them in Swan Lake than in Lake Washington, or to expect them to propagate in the city reservoirs with Cedar River water, than if Lake Washington water were supplied.

The water of Swan Lake, in October, was as good as any city could desire, and by the people who live on its shores it is said to be as good all the year round. The fact that it is full of mountain trout is a sure indication that no considerable contamination of water occurs in it.

The only tendency which sound, fresh wood has to contaminate water with which it comes in contact arises from the dissolving of the sap of the wood by the water. After the solution has once been made and carried off, it cannot be repeated. The contamination from this source cannot, at the start, be more than infinitesimal, and after the solution of the sap from the surfaces exposed to the water is completed it will cease entirely.

The people of the City of Seattle will never know, from the quality of the water, whether it is wood, iron, brick or stone of which the conduits are made that conveys the water to their houses.

To raise an objection to wooden conduits, on such grounds, in a country where nearly every drop of water in the stream from which the water is taken has been in contact with wood—and decaying wood at that—almost from the time it fell from the clouds, exhibits a hypercriticism too refined to be met by arguments.

DISTRIBUTION SYSTEM

The present corporate limits of the city cover an area of about 11 square miles, not including water surface, and extend 4½ miles north and south, and from Puget Sound, on the west, to Lake Washington, on the east, being about 2 miles wide at the narrowest place and 5 miles at the widest. The elevations attained by its surface vary from 10 feet to 460 feet above high tide. Intermediate between these elevations the surface is broken, being a succession of elevations from 200 to 400 feet high, with depressions between. In the northern part of the city lies Lake Union, dividing the territory between the Sound and Lake Washington into two high ridges, which flank it on either side. Some distance beyond the corporate limits of the city, on the north, the high ground descends into the Salmon Bay, Lake Union, and Union Bay depression, which extends through from the Sound to Lake Washington, connecting the latter lake with the Sound. Through this depression, and along the water front, now runs the Seattle, Lake Shore & Eastern Railroad. In the future this district is doubtless destined to be the route of a ship canal connecting the Sound, with what will some day be its great fresh-water harbor, Lake Washington. This depression being the only feasible entrance to the city

Source of Water Supply

which railroads can follow from the north and east, it will become a great artery of commerce, and will be filled with manufactures and a dense industrial population, as is indicated by the rapid growth of manufactories and population now taking place. South of the city extends a high and narrow, but broken ridge, lying between the Black River Valley and Lake Washington. The system of water works proposed for the city must doubtless in the near future water this whole region, from the extreme limit of population, on the south, to Green Lake, on the north, and will probably jump the Black River Valley and supply West Seattle, on the opposite shore of Elliott Bay.

This territory, which is properly the future Seattle, comprises some 46 square miles.

As was seen by the preliminary outline of the proposed works, there will be, to reach the territory within the city, as described, three distinct services, supplying as many districts, lying at different elevations. Its division into three different service districts grows out of its topography considered in relation to the source of supply.

The variation in altitude from 10 to 460 feet renders it inexpedient and almost impracticable to make one system of distribution mains cover the low and high territory alike. In the low regions the pressure would be too great, and in the high regions too small. It could have been made into two districts instead of three, only for the fact that the extreme high elevations cannot be reached from the Swan Lake reservoir and Cedar River source, without going much farther up the river, and abandoning the proposed use of Swan Lake, and vastly increasing the expense. It becomes cheaper to pump from the high service gravity reservoir for the small territory which it will not reach, rather than to have tried to reach it all by gravity.

The present corporate area is divided about as follows between the three service districts:

Low gravity service district, comprising the area below 200 feet elevation, 3,300 acres.

High gravity service district, comprising the area between 200 feet and 350 feet elevation, 2,800 acres.

High pumping service district, comprising the area above 350 feet elevation, 900 acres.

The low gravity service district, which will generally include all the territory of the city lying below a level of 200 feet, will embrace a part of the depression extending from Jackson and Sixteenth Streets southeast to Lake Washington, but its main territory follows the water front from the south, reaching as high as Fifth and Columbia Streets, widening like a fan as we go north, and finally stretching from the eastern shore of Lake Union to Elliott Bay. It will follow around both sides of Lake Union, and one branch trends northwestward around the west side of the ridge west of Lake Union, these various branches finally uniting in the Salmon Bay depression. To distribute water to this area from the low service reservoir, the mains

will have to pass through the central portion of the city, and should be capable of delivering sufficient water to meet the requirements of the low grounds to the north. In making plans for this district I have kept this in view.

In the low service district will be located manufactories and large business houses, and, in fact, nearly all of the large industries requiring the most water. Its service, therefore, becomes the most important of the three.

The high gravity service district, as stated, generally includes all territory lying between 200 and 350 feet elevation. It comprises four detached areas, separated from each other by the low service district. The larger one of these areas lies mostly north of Jackson Street, and extends from Sixth and Columbia Streets to the Lake Washington bluffs. It also skirts the eastern bluffs of Lake Union. Another one is a narrow strip of land upon which the low service reservoir is located; another the hill upon which the Denny Hotel stands, and still another one is an annular-shaped area in the extreme northern part of the city, west of Lake Union. These detached areas are to be supplied from the high gravity service reservoir.

As before stated, the main supply pipe between the two reservoirs will answer for a distribution main for this district. It passes through the two areas first mentioned. To reach the second two it is proposed to lead a 16 inch pipe off from the main supply at Broadway and Madison Streets, and to follow Madison, Ninth, Seventh, Fourth, Poplar and other streets to the area west of Lake Union, supplying in its course the Denny Hotel ridge.

The high pumping service district comprises two distinct areas; one being the upper portion of the ridge upon which the high service reservoir is to stand, and extending south of Madison Street in Section 33; another being the top of the ridge west of Lake Union.

To supply this service, it is proposed, after the new works are put into operation, to remove portions of the pumps, boilers, etc., from the pumping works on Lake Washington to the high service reservoir, and establish pumping works there, taking water from that reservoir.

To reach the part of the district west of Lake Union, a pipe will have to be laid across the valley. These works can be built on the basis of a direct supply from the pumps, or a tank can be erected on each ridge, one east and one west of Lake Union, at an elevation of 500 feet above high tide, which give all the pressure necessary for domestic purposes. The cost of carrying out this work is not included in the estimates.

ESTIMATES OF DISTRIBUTION SYSTEMS

In Appendix "B" will be found an approximate detailed estimate of the cost of carrying out the two distribution systems for gravity service, which amounts to $535,052.86.

It is based upon the proposition to reach all parts of the city that are settled to any considerable extent, and to furnish fire protection throughout, hydrants being set at each street crossing.

It is also based upon the use of cast iron pipe throughout delivered by water, around the "Horn."

The plan contemplates the division of the districts into sub-districts, by means of stop-valves, in order that the water can be shut off of portions of the city without interfering with the supply generally.

The first cost of distribution can be decreased by lopping off lines of pipes where they can be best spared, and leaving them to be put in later; and also by the use of wrought-iron pipes, particularly in the larger mains, should it be thought advisable to use them. The amount of pipe called for, however, is needed for a fairly thorough supply to the built-up portions of the city, and for the sake of fire protection, and the decrease of insurance rates, it should be put in.

The total length of pipe of all sizes, in the estimate, including hydrant connections, is 212,800 feet, or 40.3 miles. This, added to the 11.6 miles of pipe now in use in the old works, that are 4 inches and more in diameter, make 51.9 miles which the new works will have at first, if built as proposed.

POPULATION

It is usual, in estimating the probable amount of water which a city is likely to need, to base it upon the population, present and prospective.

In our rapidly growing American cities it is sometimes difficult to know the present population, and much more difficult to form an adequate idea of a city's probable growth. In the case of Seattle, which may be said to be passing through a transition period, these are especially difficult things to do.

There are other elements affecting the amount of water which should be provided, in a given case, that have often been overlooked in the past. They are the numerous purposes for which power is wanted in a city. A large demand would be made for these purposes alone, if plenty of water, at a reasonably steady pressure, was to be had. Water can be applied in so many ways, like operating machinery, and running elevators, that where it can be done, provision should be made in a generous way for such uses. Indeed, the needs in some cities for water for power purposes have become so great that steps have been taken to meet them with an entirely new stystem of works.

The City of Chicago has for several years contemplated the building of new works, in the central part of the city, which should be additional to their present works, to be used for power purposes alone. The only thing that has stood, and now stands, in the way of the carrying out of such a plan is the small limit of indebtedness fixed by the State Constitution. It is recognized on all hands that it would be a paying investment, and if the city would grant a franchise, it would be taken up immediately.

This is given only to show the need of considering every phase of the water question in planning new works, and of making provision to meet such needs, if possible.

Then, in any climate, but particularly in one where several months of dry weather prevail each year, there is nothing which adds so much to the comfort and beauty of a city as plenty of water to keep the grass green and the trees in a growing condition, and for use on streets and walks to lay the dust.

It is usual, and easy to say, that 100 gallons per capita per diem is an ample water supply to allow for cities, as there are but few in the country that use a greater amount. Half a generation ago, one-half this amount was considered a liberal allowance, and I would not be surprised if, half a generation hence, 100 gallons per capita per diem should be considered, in many places, more inadequate than 50 gallons is now, because of the multiplicity of uses to which water can and will be put if it is only furnished. It should be borne in mind that though but few cities use more than 100 gallons per capita per diem, it is because the water is not to be had, or, if to be had, it comes under such reduced head as to be practically valueless. This is the case in New York, Philadelphia and Chicago. During the sixteen years that I have been acquainted with the operation of the water works of Chicago, there has never been a time when an hydraulic elevator could be successfully run with a direct connection from the mains. This is true in New York, and in nearly all other large cities. Of the hundreds, and perhaps thousands, of hydraulic elevators at work in these two cities, they are almost always run by water pumped over and over again by a pump in the basement of the building where the water is used. But for the failure of our large cities to furnish a sufficient quantity of water, under an adequate head, the amount of water consumed by them would be vastly greater. Indeed, no one can form any adequate estimate of what it would be. Hence we should become impressed with the fact that the amount of water consumed, under the restrictive conditions which prevail generally, is no guide for a city situated as is Seattle, with reference to the proposed new works.

Though it would generally be said that 25,000,000 gallons per day is sufficient for 250,000 population, I would prefer to predict that before the population reaches 150,000, a shortage of water will be felt.

HORSE-POWER OF SURPLUS WATER

For some years to come, after the works are put into operation, there will undoubtedly be a considerable surplus of water, which will not be needed for the ordinary purposes for which water is sold. We may assume that at first there will be 16,000,000 gallons surplus, which can be used for extraordinary purposes, such as running electric lights for the city, or for manufacturing purposes.

This can be used at any point along the line of mains where they are large enough to deliver the water without too much friction, and where an outlet for the water can be had. If used without too much waste, by

friction from the low service reservoir, it would yield 800 horse power, which would probably be worth, if used economically, $20 per horse power, or say, $16,000 per annum.

REVENUE AND EXPENSE

The present revenue of the Spring Hill Water Works, which is being acquired by the city, is about $80,500 per annum, exclusive of hydrant rental. If sufficient water could be pumped, and the mains were large enough to distribute it, the revenue could be increased at least $25,000 or to $105,500 per annum, in a very short time, without any increase in the mileage of the mains. This possible increase would be in furnishing water to be used in elevators and buildings that are known to the company as wanting water, and does not incluude the ordinary natural increase which goes on regularly month by month, and which amounts to about $300 per month. With the increase proposed in the lengths of mains, in the plans for new water works, will come a large additional revenue from buildings now erected, and in use. And by the end of the year 1891 another large element of increased revenue will be the buildings which will be erected and the industries which will be started between now and then. If 40 miles of pipe are laid during the next two years, with a prospect of plenty of water at the end of that time, I believe it extremely conservative to say that the gross revenue will double; that is, that by the first of January, 1892, it will be $211,000, if no modification is made in the water rates. In this I have the concurrence of Mr. E. Shepard, of the Spring Hill Water Company, whose intimate acquaintance with all matters pertaining to the subject renders him a most valuable judge.

Another item which will be to the city's credit is the hydrant rental. There are now in use, and provided for to be put into immediate use, 100 fire hydrants, for which the city pays $90 per year a piece. This, without any increase in the number of hydrants, amounts to $9,000 per annum. But if the Spring Hill Water Company had continued in business, and had put in anything like an adequate distribution system, and water to supply it, there would have been in use by the time stated, at least 300 hydrants, whose rental would have amounted to $27,000 per annum, which will have been saved to the city by the city owning its own water works. This makes a probable gross sum in the citv's favor, by January 1, 1892, by owning its own water works, of $238,000 per annum.

As an offset to this will be the interest on the cost of works and the cost of operation.

The cost of the proposed works, including the purchase price of the Spring Hill Water Company's plant and real estate, mav be taken in round numbers at $2,100,000, the interest of which at 5 per cent is $105,000 per annum.

The cost of operation will consist of the expense of looking after the supply and the expense of maintaining the distribution system, and of collecting water rates and repairs. To look after the supply, that is, to care for everything up to and including the delivery of water in the reservoirs, will probably require men as follows: One guard, or watchman, who shall live at Swan Lake, and take care of the lake and the inlet to the tunnel, and go at intervals over the line of the flume to Cedar River, and one attendant and assistant, to look after reservoirs and attend to the opening and closing of valves at the low service reservoir. Suitable men for such work can be had at the rate of $900 per annum for the principals, and $750 for assistants, making $2,550 for the three.

The expense for the distribution and collection of water rates, is estimated at $17,500 per annum, the basis of estimate being the cost for like work to the Spring Hill Company at the present time, with allowance for additional work caused by an increase in the number of water takers, and an increased mileage of pipes. This makes a total cost for operations of $20,050 per annum, which added to the interest charges, gives $125,050, as against $238,000, which has been placed to the credit of the city by reason of its owning its own works, leaving a net gain of $112,950 per annum, which can be used in extensions, or be placed to the credit of a renewal or sinking fund.

This is a showing which the city, as a corporation, may reasonably expect in two years if the work, as proposed, is carried out. In the meantime, the revenue from the present works will pay the interest on the cost of the works. In addition to this, the city will have some 800 horse power in surplus water, of which such portions as are needed may be used to run an electric light plant, and the remaining portion used temporarily for other purposes.

It should not be forgotten, in this connection, that the revenue from water works, is a thing which never ceases to grow. It is universally the case that, even in a city of very conservative growth, with a well-built system of water works, the revenue increases far more rapidly than the expenses. This is true where the water is supplied by pumps, and where the expense of pumping necessarily sustains a close relation to the amount of water used. It will be doubly true in a city that bids fair to have a rapid growth, and where there will be no increase in the cost of supplying water until the 25,000,000 gallon limit is passed. If the proposed works are built, it will cost no more to supply 25,000,000 gallons, than to supply 5,000,000 gallons, which would be far from being the case if the water was supplied by pumps, instead of by gravity.

INDIRECT RETURNS

Thus far the gain that may be expected from the building of new water works, which will accrue to the city as a business institution, as distinct from the general interest of its citizens, has only been considered. There are still larger benefits, of a consequential nature, which will come

to the city as a whole, outside of its corporate capacity, that cannot be expressed in figures, but which are just as real, nevertheless, as if they were given to the cent. Some of these are the saving of expense to householders now off the lines of water pipes, that is incurred in impounding water in cisterns and in obtaining it from wells; the enhancement of the value of real estate, by reason of the city becoming a more desirable place in which to live, and a cheaper place in which to do business; also, in the saving of losses from fire, but more particularly in the reduction of insurance rates.

All premiums paid on insurance policies are a dead tax upon the people, for which there is absolutely no return. They never come back. The payment of a fire loss does not return them; it merely substitutes, partially, one kind of loss for another, the loss from fire being prevented only by reason of a loss previously incurred in the payment of premiums.

Anything which will lessen the hazard from fire, and reduce insurance rates, thereby saves a measurable sum to the city each year. It does not save it to the grocer, or to the clothing merchant; it saves it to the person who eats the groceries of the one, or wears the clothes of the other.

By the kindness of Messrs. Taylor and Burns, gentlemen well posted in fire insurance matters, I am enabled to give some approximate figures of what this premium saving may be. They estimate that at the time of the fire of last June, there were policies amounting to $4,000,000 outstanding, upon which premiums had been paid at rates averaging 4 per cent per annum. After the fire, losses were paid amounting to $2,600,000.

They are of the opinion that the average rate of premiums now paid amounts to at least 6 per cent per annum, and that within a year the policies upon which this rate is paid will be as much as $8,000,000, and that, by the building of water works which will furnish plenty of water for fire purposes in all parts of the city, this rate will be reduced one-half, or to an average of 3 per cent, making a saving of 3 per cent on $8,000,000, or $240,000 per annum.

They state that the only reason premium rates remain as low as they are at the present time is because of the promise of a better water supply that has been held out to the insurance companies, and that if more adequate water works were not to be built rates would go still higher.

To sum it all up, it may be said that the corporation will be deriving a net revenue of $112,950 per anum by the time the proposed new works are put in operation; that by reason of the fact of their going into operation, the aggregate premiums paid on insurance policies will effect a saving of $240,000 per annum to the people as a whole; and that in addition to this there are indirect benefits which will be derived that cannot be even approximately stated in figures, but surely aggregating far more than the other items combined.

In bringing the engineering work to its present stage, I am indebted to Messrs. Scurry and Owens for the prompt and efficient manner in

which the required surveys have been made and platted, the best routes searched out, and all necessary data furnished; and to Mr. John Ericson, for the valuable assistance he has rendered me during the whole progress of the work.

In conclusion, I have to thank his Honor the Mayor, and the Committee on Fire and Water, as well as all members of the Council with whom I have come in contact, for the uniform courtesy they have extended to me, and for many valuable suggestions relative to the plans as a whole.

Respectfully submitted,

BENEZETTE WILLIAMS,

Chief Engineer.

Seattle, Feb. 21, 1890.

APPENDIX A.

Estimate of the cost of aqueducts, dams, reservoirs, etc., necessary to take water from Cedar River, as proposed and to deliver it in city reservoirs:

400 acres of clearing right-of-way, etc., @ $90.00....		$ 36,000.00
70 acres of grubbing right-of-way, etc., @ $160.00....		11,200.00
337,000 cubic yards of excavation in reservoir, dams, and in grading pipe and flume lines, @ 40 cts.....		134,800.00
92,800 lineal feet of 42 inch supply pipe @ $7.50....		696,000.00
5,300 lineal feet of tunnel at Swan Lake @ $12.00....		63,600.00
36,100 lineal feet of open flume in earth @ $2.10....		75,800.00
1,700 lineal feet of open flume on bents and trusses @ $6.00		10,200.00
4,000 lineal feet of 48 inch wooden pipe on line of flume @ $4.50		18,000.00
16,042 square yards of bottom paving in reservoir @ $1.60	$25,667.20	
8,333 square yards of slope paving in reservoir @ $2.60	21,665.80	
240 cubic yards asphaltum concrete @ $20.00..........	4,800.00	
10 cubic yards of Portland cement concrete @ $12.00	120.00	
21,000 bricks laid in Portland cement mortar @ $30.00	630.00	
2,900 lineal feet of overflow conduit @ $1.70..........	4,930.00	
Finishing grounds and slopes, soiling and seeding reservoir	1,000.00	
		58,813.00
Cedar River dam, exclusive of earthwork		9,700.00
Inlet crib gate and foot bridge at Swan Lake		1,700.00
Weir shaft at end of tunnel		500.00
Iron pipe at Black River crossing, laid		4,800.00
250,000 pounds of castings in manholes, connections, blow-offs, curves, etc., in place @ 7 cents..........		17,500.00
2,000 lineal feet of culvert pipe, in place @ $2.50....		5,000.00
		$1,143,613.00
Add 5 per cent for superintending and engineering....		57,180.65
TOTAL		$1,200,793.65

APPENDIX B

Approximate estimate of the cost of furnishing and laying distribution pipes, fire hydrants, valves, etc., for the low service and high service gravity districts.

15,000 ft. of 4 in. pipe, @ $0.70 per ft., laid	$10,500.00	
68,000 ft. of 6 in. pipe, @ 1.00 per ft., laid	68,500.00	
33,700 ft. of 8 in. pipe, @ 1.30 per ft., laid	43,810.00	
8,700 ft. of 10 in. pipe, @ 1.70 per ft., laid	14,790.00	
21,100 ft. of 12 in. pipe, @ 2.15 per ft., laid	45,365.00	
26,300 ft. of 16 in. pipe, @ 3.30 per ft., laid	86,790.00	
20,900 ft. of 20 in. pipe, @ 4.50 per ft., laid	94,050.00	
10,500 ft. of 24 in. pipe, @ 6.00 per ft., laid	63,000.00	
8,100 ft. of 30 in. pipe, @ 7.75 per ft., laid	62,775.00	
		$489,580.00
12 4 in. stop valves, @ $9.10 per piece	109.20	
100 6 in. stop valves, @ 14.80 per piece	1,480.00	
30 8 in. stop valves, @ 23.30 per piece	699.00	
7 10 in. stop valves, @ 31.23 per piece	218.61	
12 12 in. stop valves, @ 42.23 per piece	506.86	
3 16 in. stop valves, @ 91.20 per piece	273.60	
5 20 in. stop valves, @ 152.00 per piece	760.00	
7 24 in. stop valves, @ 233.83 per piece	1,636.81	
1 30 in. stop valve, @ 310.08	310.08	
1 42 in. stop valve, @ 500.00	500.00	
300 fire hydrants, @ $45.00 per hydrant	13,500.00	
		$19,994.16
		509,574.16
Add 5 per cent for superintendence and engineering		25,479.70
Total estimated cost of distribution system		$535,053.86

Seattle, February 3, 1891.

To the Honorable,
The Board of Public Works,
Seattle, Washington.

Gentlemen:

I have filed with the City Engineer specifications for the proposed works for supplying the City of Seattle with water from Cedar River. They cover a high service reservoir, the main supply pipe, tunnel, flumes, dams, etc., necessary to bring water from Cedar River and store it in the city ready for delivery into the distribution system.

These specifications are a copy of old ones revised so as to conform as nearly as practicable to the latest acquired knowledge, and to my most mature judgment touching the questions involved. I have also annoted them in a few instances covering points about which owing to insufficient data, and to too meagre investigations, both in time and extent, my mind is in doubt as to the best course to pursue.

Although all official connection with the Seattle Water Works is completely, and doubtless finally severed, I trust that it will not be considered impertinence for me to place upon record some suggestions and

Cedar Lake in Winter

observations, relative to a number of points connected with these works, which are decidedly out of place in the specifications, and also to a certain extent, in my previous general report upon that subject.

The fact that in entering upon the work it was the expectation that I would continue with it and direct it to completion, coupled with the further fact that owing to the exigencies of the case I was unable to have investigations on certain lines carried to the extent which was necessary to a final determination of the detail questions involved, must be my apology for intruding this upon your notice. If further extenuation is necessary I trust that it may be found in the interest which I take in what may, with more or less propriety, be termed the child of my brain, and in the desire which I feel that this work may ultimately be carried out in its full completion by the city.

The work is of a nature that will need the most careful superintendence during its construction, and there will certainly arise many problems which will require a thorough engineering knowledge to decide. This will doubtless be furnished as occasion demands, but in order that the suggestions which occur to me now may be available for what they are worth I present them under appropriate headings.

USE OF SWAN LAKE AS A RESERVOIR

In my report to the City Council, of February 21, 1890, the reasons for the use of Swan Lake as a head, or impounding reservoir, were set forth. I see no reason to change the opinions then given as to why it is advantageous to use it, except to emphasize those of safety and economy.

In the matter of safety: there must necessarily be some hazard to all dams built on mountain streams, having a quick descent, and that are subject to floods. This hazard is increased in a wooded country where brush, and fallen trees are liable to become entangled and form a jam. This alone would be sufficient warrant for the use of some sort of a reservoir that can be relied upon to furnish the city with water while the dam on Cedar River is being rebuilt, should it be carried away, even if to provide such a reservoir should add a considerable sum to the cost of the work.

Then in the matter of the avoidance of liability to land slides, it is very important that the pipes and flume line be kept well inland away from the steep and treacherous banks of the river. By going via Swan Lake this is wholly accomplished I believe on the pipe line, and nearly so on the line of the flume. By the use of the lake, however, injury to the flume will not be a serious matter.

The greater knowledge which I have derived during the past year regarding the lakes which are scattered throughout this part of the State of Washington, has suggested to my mind the possibility of the growth of fresh water *Algae* in Swan Lake during certain seasons of the year, which

may at times be the cause of an unpleasant taste to the water. This undoubtedly occurs in Lake Washington, and is probably the secret of the complaints about the bad taste of the water now furnished. To what extent, if at all, a similar condition obtains in Swan Lake is a matter of conjecture only. At the time of my investigation the waters of this lake were all that could be desired, being free from discoloration and taste.

Of the minute forms of plant life known generally as Fresh Water *Algea*, at least fifteen hundred species have been described as peculiar to the United States. The disagreeable taste which not unfrequently occurs in the water supply of a number of cities of the country, where reservoirs, ponds, or lakes are used, is due to some one or more of these species of *Algae*. In some localities the propagation of *Algae* to a harmful degree does not occur every year, and generally lasts only for a short time. There is also a great difference in the degree to which they propagate in different localities, and even in different lakes or reservoirs in the same locality.

In some lakes in this region they so abound as to give the water a deep green hue. The propagation of some variety of *Algae* may or may not occur in the city reservoirs in Swan Lake, or even in Cedar River. Some miles above the proposed site of the Cedar River dam there is said to be a large lake known as Lake Garfield, through which Cedar River flows. There is hence even a possibility that the river water may at times be affected by *Algae*.

In many cases there is no remedy for the evils arising from this cause, but as far as possible the conditions most favorable to the growth of *Algae* which can effect the water supply should be avoided.

I had hoped that during the summer and fall examinations might have been made at regular intervals of the water of Cedar River and of Swan Lake, to discover whatever *Algae* growth may exist at any time in either water. It was not possible to do this, however, and I can only call your attention to the need of a systematic examination of water from both sources before Cedar River work is finally entered upon. Whatever plant life of this kind may be found to exist in Cedar River, will have to be borne with, as there is certainly no other source of supply available which will be freer from such drawbacks.

If it is found to prevail to any considerable extent in Swan Lake only, the difficulty may be met, without great expense, by continuing the open flume line around the northern border of the lake and by discharging the water from Cedar River either into the inlet of the tunnel or into the tunnel itself direct. In either case the lake inlet to the tunnel could always be kept open, so that in case of the supply of water through the flume being cut off, the city supply would come from the lake, and any water delivered by the flume, which was not carried off by the tunnel, would flow into the lake. It is not desirable to make this change unless it is found to be necessary.

FLUME

The proper line for the open flume from Cedar River to Swan Lake has been approximately established by a very thorough topographical survey of the immediate country.

Should it be found desirable to continue the flume around the northern borders of Swan Lake, a change will be necessary in its grade and hence to a certain extent in its alignment.

A part of the ground through which this flume is to be built is so porous that, at the time, I deemed it desirable that the flume should be lined to make it water tight. It is not at all certain, however, but that for a considerable part, if not for all the way, the lining can be dispensed with and the channel constructed wholly in the ground. In this event the slope of the flume will have to be reduced to such an extent that the velocity of flow will not erode the sides. This renders the greater cross section necessary, but it will reduce the cost of the work to such an extent that if desired the canal can be extended around the lake as suggested, without increasing the cost above that given in the estimate.

The line of the flume as shown on the map crosses a bend of the Cedar River bottom some distance below the proposed dam, making two bridges over the river necessary. It may be much better to build a tunnel through the ridge on a line marked on the map, thus shortening the distance and avoiding the river crossing. To do this a detour from the correct course is necessary. If the ground through this ridge is well suited for tunneling, the tunnel may be found even cheaper than the other route, but as it would be greatly superior in every way, a somewhat greater expense might well be borne for the sake of the advantages to be derived from the tunnel.

When construction is determined upon, the cost of this part of the work will be greatly dependent upon the care and skill exercised in the final location of the line, and the manner in which it is to be handled is not one of the least important things to be considered.

SUPPLY PIPE

The wooden pipe, built as provided for in the specifications, is believed to be not less durable than riveted steel plate pipe, and in fact it is altogether probable that it may be found to have a greater life than the steel pipe. It will require special care and skill in its construction however, and rather than to take any risk on this score it will be better for the city to use the steel plate pipe. I have therefore made specifications for steel pipe as a substitute for the wooden pipe, and would recommend that when it comes to the matter of construction, bids be received for each kind and leave the decision as to which shall be used to be made in the light of their relative costs, and the probabilities of the work falling into skillful and faithful hands.

In order to get equal capacity in the two kinds of pipe, it is necessary that the steel pipe should be larger owing to the roughness and unevenness of its interior surface. The diameter of the steel pipe has therefore been fixed at 44 inches in order that it may be the equivalent of the wooden pipe of 42 inches diameter.

The best line for this pipe to follow has generally been pretty well determined.

At the Black River, however, thorough soundings of the ground are necessary to a decision as to the best manner of crossing. Rock is known to be in the way of sinking the pipe by dredging in the bed of the river. But whether a channel should be blasted through the rock in which the pipe can lie or whether it will be best to take it through a tunnel in the rock below the bed of the river are questions yet to be determined. Under no circumstances should any plan of crossing above the stream be considered. It is all well enough to take some chance on the flume line from Swan Lake to Cedar River, but hazard to the pipe line should be avoided at any cost.

The specifications for wooden pipe provide the manner in which the iron hoops shall be proportioned and spaced on the pipe. It is not practicable to give this in detail until the line is fully determined upon and a final profile made. This is an important feature and must be done by some one who understands thoroughly the principles underlying the proportioning of the hoops to the strains upon the pipe.

STANDPIPE

In my report of February 21, page 12, I called attention to the need of some provision by which shock to the pipe can be avoided, and suggested either relief valves, or a stand pipe at the low service reservoir. On consideration of this question I have come to the conclusion that a stand pipe should be built, located at the low service reservoir, the top of which shall reach to the height of the hydraulic grade line. To do this it would have to be about 135 feet high. The pipe would need to be a double one. A pipe three feet in diameter, with its top at just such a height that it will not overflow when the discharge is taking place into the high service reservoir should stand inside of a pipe, five feet in diameter, which is connected with the low service reservoir, the top of the large pipe being fifteen feet higher than the small pipe.

It is the intention that the water shall flow constantly through the supply pipe, the flow never being stopped except by closing the gate at Swan Lake. By closing a gate between the two city reservoirs the water will overflow the stand pipe without bringing shock upon the pipe. By providing this stand pipe, and placing no gate between it and Swan Lake, matters will be so arranged that by no possibility will the main pipe be unduly strained. No design has been made for this stand pipe, as it was the intention to plan it in reference to, and at the same time with, a new low service reservoir, which has never been made a part of the estimates.

This is a most important adjunct, and attention is called to it in order that it may not be overlooked, and the safety of the supply pipe jeopardized, as it would be by an attempt to close a valve between two reservoirs without it.

HIGH SERVICE RESERVOIR

The plan for the high service reservoir involves a form of construction which is wholly dependent upon the inside lining or pavement to render it water tight. As in all cases when water is to be confined in a basin, the greater care must be exercised in its construction to guard against leaks. Its banks must be built so solidly that no settlement will occur after it is lined or a leak may follow. The lining must have the care of a ship's sides during construction if success is to be obtained.

In fixing upon the capacity for the high and low service reservoir it was thought desirable that they should hold enough water for several days' supply after the city shall have passed the 200,000 limit of population, or say 25,000,000 gallons for the high service and 50,000,000 gallons for the low service.

As designed the high service reservoir has a capacity of about 26,500,000 gallons. Should it be thought desirable in view of the fact that the Cedar River plan will not be carried out for some years, the capacity of these reservoirs can be reduced. By shortening it 200 feet it will still hold 17,000,000 gallons.

The overflow conduit provided from the foot of the bank to Lake Union is of cheap construction and is only meant to be temporary. So long as the reservoir is used with the pumping plant this conduit can be dispensed with.

PUMPING PLANT

If we assume that it is the policy of the city to carry out the plans for the Cedar River supply at as early a day as may be financially possible, and to so construct the work inside of the city that it may become part of the completed whole, then whatever enlargement or addition to the pumping plant the necessities of the case may require, should be made with this policy in view, and nothing should be done inconsistent with the theory that pumping is but temporary, and that the gravity supply is to be permanent.

Working to this theory it will not be advisable to select pumps of the expensive high duty class which are in place in a permanent plant, but rather to take the cheaper class that do not give so great economy in operation. Considering the low price of coal, and the great first cost of what are known as high duty pumps, it will be found that a less expensive kind, such as are in use at the pumping works, will be the cheapest in the end.

They do not require so high a grade of engineering ability to operate them, which is another element of cheapness.

In fixing upon the capacity which new pumps should have, consideration should be given to the probable rate of growth of the city, the time which it will take for the city to have a sufficiently high assessed valuation to enable it to raise money for the gravity system, and to that point in the growth of its water system when the cost of pumping will equal or exceed the interest on the cost of the gravity supply works. I purposely omit the question of the sanitary merits of the two supplies. Being one about which the people are very sensitive, no good purpose can be subserved in discussing it, when there is no hope of an early change.

If we are to judge the probable rate of growth of Seattle by the history of other cities in the United States, which during the last two decades have attained a population of from 40,000 to 50,000, we would conclude that in ten years the population of Seattle will be at least 150,000, and that in six years it may reach 200,000. For my part I believe these are not extravagant expectations. By the time the city has 100,000 people, if a general distribution shall have been laid, it will probably be using eight or ten millions of gallons per day; also by the time it reaches this size, and no doubt earlier, the money can be had to carry out the Cedar River plans.

If the high service reservoir and the supply pipe line from Yesler Avenue to the reservoir shall be built in the meantime, it will, after these are done, take about $1,000,000 additional to complete the Cedar River plans. This is 5 per cent or $50,000 per year. Hence as soon as the cost of operating the Lake Washington pumping works exceeds $50,000 it will be cheaper to construct the Cedar River Works.

It is of course impossible to tell at just what point in the growth of the city this will be reached, but it will probably be about the time when the consumption of water shall have reached six or seven millions gallons per day, and this will be likely to occur when the city shall have added one half more to its population, or say when it has from 70,000 to 75,000 population.

To sum the possibilities up, I should say that to provide for a net easy capacity of nine or ten millions gallons per day would be to go to the maximum limit of what it is advisable to do in the way of enlargement. If we set apart the two Worthington pumps now in use for high service exclusively, they will doubtless prove adequate for such service until the total water consumed by the city shall reach 9,000,000 gallons, and they may be called upon to supply 2,500,000 gallons of this, leaving 6,500,000 gallons to be supplied by pumps used exclusively for the low service system. The old Spring Hill pumps should be able to supply 1,500,000 gallons with ease; there will hence be needed new pumps with the capacity of say 5,000,000 gallons in twenty-four hours to pump into the low service reservoir. But to provide a sufficient relay there will

be needed a gross capacity of 7,500,000 gallons, or say three pumps of about 2,500,000 gallons capacity each.

Three Direct Acting Duplex Pumps of the Worthington type with 14 inch water ends will do this with ease. If such were provided there would then be six pumps, not counting the small Spring Hill pump, having a very easy aggregate capacity of 12,000,000 gallons and which can readily reach by a little urging 15,000,000 gallons, or allowing for a part of them lying idle, they can furnish at least 10,000,000 gallons. Long before this capacity shall be fully used in supplying the city, the cost of operating the pumping works will exceed the interest on the cost of the Cedar River supply, and we can reasonably hope also that before that time the city will be able to carry the work out. It would, of course, not be absolutely necessary to purchase more than two of these pumps at first, leaving the third one to be added as occasion may require.

A force main twenty inches in diameter leading from the pumping works to the low service reservoir, together with the old main now in use, will meet the requirements of such a plant, and it will be useful as a distributing main when the pumping plant shall be abandoned.

In closing, I wish to acknowledge my indebtedness to each member of the Board for the courtesy and consideration which I have received at your hands. I wish also to assure you that if at any time you need explanations touching anything which may arise relative to the plans and specifications, I shall be pleased to make them.

Respectfully submitted,

BENEZETTE WILLIAMS.

Scene in Watershed

Cedar River Basin

GENERAL FEATURES

(From U. S. Water Supply Paper 292—1910) Amended up to January 1, 1914.

"Cedar River heads in Yakima Pass at an elevation of 2,500 feet and flows west and a little north 45 miles to its junction with Lake Washington. The basin is long and narrow, extending northwest and southeast from the southern end of Lake Washington near Seattle, to the Cascade Range, and comprises 240 square miles. Cedar Lake, which covers an area of 1,200 acres, lay 1,530 feet above sea level before the dam was built, and is 12 miles from the source of the river. Rex River, a stream 8 miles long, the only important tributary, enters Cedar Lake from the southeast.

Evidences of glaciation are very marked in the upper portion of the basin; remains of terminal moraines are still noticeable below the outlet of Cedar Lake. The elevations of the peaks along the main ridge of the Cascade Range are from 5,300 to 5,400 feet. The mountain sides are very steep and several of the small feeders at the head waters rise in glacial cirques.

At a point about two miles below Cedar Lake the river takes a very steep gradient over a number of cascades and through a narrow V-shaped valley. Within three miles in this section of the river the fall averages nearly 200 feet to the mile. Of this fall 600 feet is made use of by the Seattle municipal power plant, which takes water through an 18 foot timber dam and carries it through the side of the valley or canyon by wood-stave pipe lines and steel penstock to the plant located near Cedar Falls. The topography in the vicinity of Cedar Falls is such that it appears likely that Cedar River at one time was tributary to the South Fork of Snoqualmie River. The bed of the river a short distance below Cedar Falls is only a few feet lower than the divide separating the two basins.

The entire basin below the timber line is well covered with fir, hemlock and cedar. The City of Seattle has acquired 117 square miles of

land within the basin by condemnation, by actual purchase, and from the Forest Service for the purpose of insuring the continued purity of water and uniformity of flow for the gravity water supply system.

The precipitation on the Cedar River basin ranges from a mean annual of 36 inches at Seattle to about 112 inches at the crest of the mountainous area. Records kept at the intake of the municipal pipe lines, elevation 535 feet, give an average of 56 inches for the 2 years, 1909 and 1910. Between 85 and 90 per cent of this amount is contributed during the eight months, October to May, inclusive. Perhaps 70 per cent of the precipitation occurs as snow which remains on the ground throughout the winter above the level of Cedar Lake. The melting of this snow in the spring occasions the floods at that season of the year. During August and September the water supply is derived almost entirely from the ground water storage, so that a very low minimum flow obtains. A minimum of 0.65 second-foot per square mile was recorded in September, 1902. This is exceptionally low for the Puget Sound basin. The years 1897 and 1899 appear to have been years of high run-off, and 1905 and 1907 years of low run-off.

Cedar Lake offers excellent opportunities for storing water for regulating the flow of the river. The storage obtained by the temporary timber dam is 16,900 acre-feet. A masonry dam is now in process of construction which will raise the elevation of the lake to 1,590 feet. This will provide 111,000 acre-feet of storage, and increase the area of the lake from 1.91 square miles to 5.23 square miles.

CEDAR RIVER NEAR RAVENSDALE, WASH.

This station, which is located at the intake of the pipe line which furnishes water to the City of Seattle, 15 miles below Cedar Lake and 1½ miles north of Ravensdale, was established September 27, 1902.

The data obtained at this station are of great value, as they are continuous and reliable and constitute the only stream flow data for any long period on the western slope of the Cascade Range in Washington.

The flow is obtained from the formula $Q=3.75LH^{3/2}+50$. The gage heights represent the head of the water (H) on the crest of the dam. The length of the crest (L) is 120 feet. It is steel shod, of triangular sec-

tion. The upstream slope forms an angle of 30 degrees with the horizontal and the downstream slope an angle of 60 degrees. For this dam a mean of the coefficient obtained from the current meter measurements made from 1902 to 1906 gives a value of c=3.76, while the mean obtained from a set of weir experiments for a dam of similar type is approximately 3.73. (See Water-Supply Paper 200, Pl. X, series 140.) In computing the rating table "c" has been given the value of 3.75. The quantity 35 was formerly added as the amount diverted into the pipe line. This diversion varies within small limits, but 35 second-feet has been used to the end of 1909 in computing the run-off for this area. A second pipe, with a capacity of about 70 second-feet, was put in service about October, 1909, and since that time the diversion has been about 50 second-feet. The datum of the gage was set to coincide with the crest of the dam at an elevation of 536 feet above sea level. The gage had not been checked for several years until April, 1911, when it was found to read 0.11 foot too high. It is not known when the change occurred, but it has been assumed to have been in this condition throughout 1910. The results for 1909, 1910 and probably a little earlier, are therefore uncertain and subject to revision, and are held for further study."

AREA OF WATERSHED

The following figures give the area of the watershed in detail, the area submerged and the impoundage of water under different heights of dam:

	acres	sq. miles
Lands acquired by City	43,825.18	68.48
Northern Pacific Ry. Co. Land	14,187.31	22.17
U. S. National Forest Lands	22,145.64	34.60
Other lands under various ownerships	9,616.51	15.02
Total Land Area	89,774.64	140.27
Cedar Lake at 1,546 ft. elevation	1,586.00	2.47
Walsh Lake	111.10	.17
Total Area of Watershed	91,471.74	142.71

The above area is somewhat larger than the drainage basin, as the 40 acre tracts along the crest line are included in full. The actual area of the watershed is about 137 square miles. The area given by the U. S. Geological Survey is 149.09 sq. miles. The difference is partly due to the undetermined crest line southeast of Landsburg.

AREA AND CAPACITY OF IMPOUNDING BASIN

	feet	acres submerged
Area of Cedar Lake original elevation	1530	1222
Area of flow line of timber dam	1546	1586
Area of flow line of temporary masonry dam	1555	1834
Area of flow line of permanent masonry dam	1590	2847

	cu. ft.
Usable storage volume, timber dam	720,000,000
Usable storage volume, temporary dam	2,357,000,000
Usable storage volume, permanent dam	5,720,000,000

The above dams, while primarily needed to impound water for the electric plant, will increase fourfold the flow of Cedar River at Landsburg, furnishing an ample supply during the dryest weather in summer for the needs of 4,000,000 people.

MINIMUM FLOW OF CEDAR RIVER AT LANDSBURG

During August, 1901, occurred the lowest run-off ever recorded at Landsburg on Cedar River. This was before the dam at the lake had been built and when there was no artificial impoundage of water. The average height of the water for the month above the crest of the dam was .36 of a foot.

Using the formula $Q=(3.75LH^{3}|^{2})+35$ adopted by the U. S. Government, we have $3.75\times120\times.216+35=132$ cubic feet of run-off per second, 35 second-feet being the quantity diverted into the pipe. The dam is 120 feet long at the crest. As the daily capacity of pipe line No. 1 is 22,500,000 gallons, the lowest run-off would be 132/35 of that amount, or 84,857,000 gallons, which, at 100 gallons per day per capita, is enough to supply a population of 850,000 people, nearly three times the present population of the city.

If we take the average number of gallons per day per capita that actually passed through the metered services in the city during the year 1913, viz.: 72.13 gallons, we find that the above daily flow would supply a population of 1,176,000 people. It will thus be seen that so far as the city's water supply is concerned, Cedar River, during the dryest month of the dryest year, can without storage above the intake, supply ample for nearly four times our present population.

ESTIMATED DISCHARGE OF CEDAR RIVER AT LANDSBURG, WASHINGTON

(Drainage area estimated at 150 sq. miles.)

Year	Segregation	Cubic Feet per year	Total per year	Average per Year		
				Second, Feet	Acre, Feet	Depth, in inches
1902	Over dam......	20,195,654,400	21,299,414,400	675.4	488,967	61⅛
	Through pipe...	1,103,760,000	....	....	....	....
1903	Over dam......	23,242,032,000	24,345,792,000	772	558,902	69⅞
	Through pipe...	1,103,760,000	....	....	....	....
1904	Over dam......	19,331,568,000	20,435,328,000	648	469,130	58⅝
	Through pipe...	1,103,760,000	....	....	....	....
1905	Over dam......	16,461,792,000	17,565,552,000	557	403,249	50⅜
	Through pipe...	1,103,760,000	....	....	....	....
1906	Over dam......	21,633,696,000	22,737,456,000	721	522,023	65¼
	Through pipe...	1,103,760,000	....	....	....	....
1907	Over dam......	18,984,672,000	20,088,432,000	637	461,167	57⅝
	Through pipe...	1,103,760,000	....	....	....	....
1908	Over dam......	20,611,342,000	21,715,102,000	687	498,510	62¼
	Through pipe...	1,103,760,000	....	....	....	....
1909	Over dam......	23,541,624,000	24,881,904,000	789	571,210	71⅜
	Through pipe...	1,340,280,000	....	....	....	....
1910	Over dam......	19,244,880,000	20,821,680,000	660	478,000	59¾
	Through pipe...	1,576,000,000	....	....	....	....
1911	Over dam......	18,355,000,000	19,931,000,000	632	458,000	57¼
	Through pipe...	1,576,000,000	....	....	....	....
1902-1911	Average for 10 years..........		21,382,166,040	677.8	490,916	61⅜

As the rainfall at different points in the watershed varies from 50 to 130 inches per year, the average fall at Landsburg has no particular relation to the amount of run-off. The average at the dam at Cedar Lake is 112 inches per year.

THE CEDAR RIVER GRAVITY WATER SUPPLY SYSTEM

Headworks, consisting of dam, weir, settling basin, intake canal, gatehouse, dwelling house and stable.

Pipe Line No. 1 consisting of:

		feet		
54	in. wooden stave pipe	2,673		
44¼	in. wooden stave pipe	71,328		
42	in. wooden stave pipe	*40,866		
		114,867	=	21.75 miles
42	in. steel riveted pipe..	36.008	=	6.82 miles
Total pipe line No. 1	....			28.57 miles

*The original length of 42 in. wooden pipe laid was 44,794 feet but 3,928 feet of it was replaced by steel during 1912.

Pipe Line No. 2, consisting of:

	feet		
54 in. wooden stave pipe	2,709		
60 in. wooden stave pipe	61,993		
51½ in. wooden stave pipe	55,751		
48 in. wooden stave pipe	22,094		
42 in. wooden stave pipe	7,910		
36 in. wooden stave pipe	1,185		
Total wooden stave pipe	151,651	=	28.72 miles
51½ in steel pipe	7,740		
48 in. steel pipe	3,036		
42 in. steel pipe	15,967		
36 in. steel pipe	1,355		
Total steel pipe	28,098	=	5.32 miles
Total pipe line No. 2			34.04 miles
Total mileage of pipe both lines			62.61 miles
Elevation of dam at Landsburg			535.8 feet
Capacity of Pipe Line No. 1 per 24 hours			22,500,000 gals.
Capacity of Pipe Line No. 2 per 24 hours			44,769,000 gals.
Total daily capacity			67,269,000 gals.

VELOCITY OF FLOW IN PIPE LINES NO. 1 AND NO. 2

Cross sectional area of pipe line No. 1, 42 inch pipe—9.621 square feet.

This pipe line has a theoretical delivery of 3,000,000 cubic feet per day, which equals 125,000 cubic feet per hour, which equals 2,083 1-3 cubic feet per minute, which equals 34.7 cubic feet per second.

$34.7 \div 9.62 = 3.6$ feet per second—velocity of flow in pipe line No. 1.

Cross section area of pipe line No. 2, 51½-inch diameter—14.466 square feet.

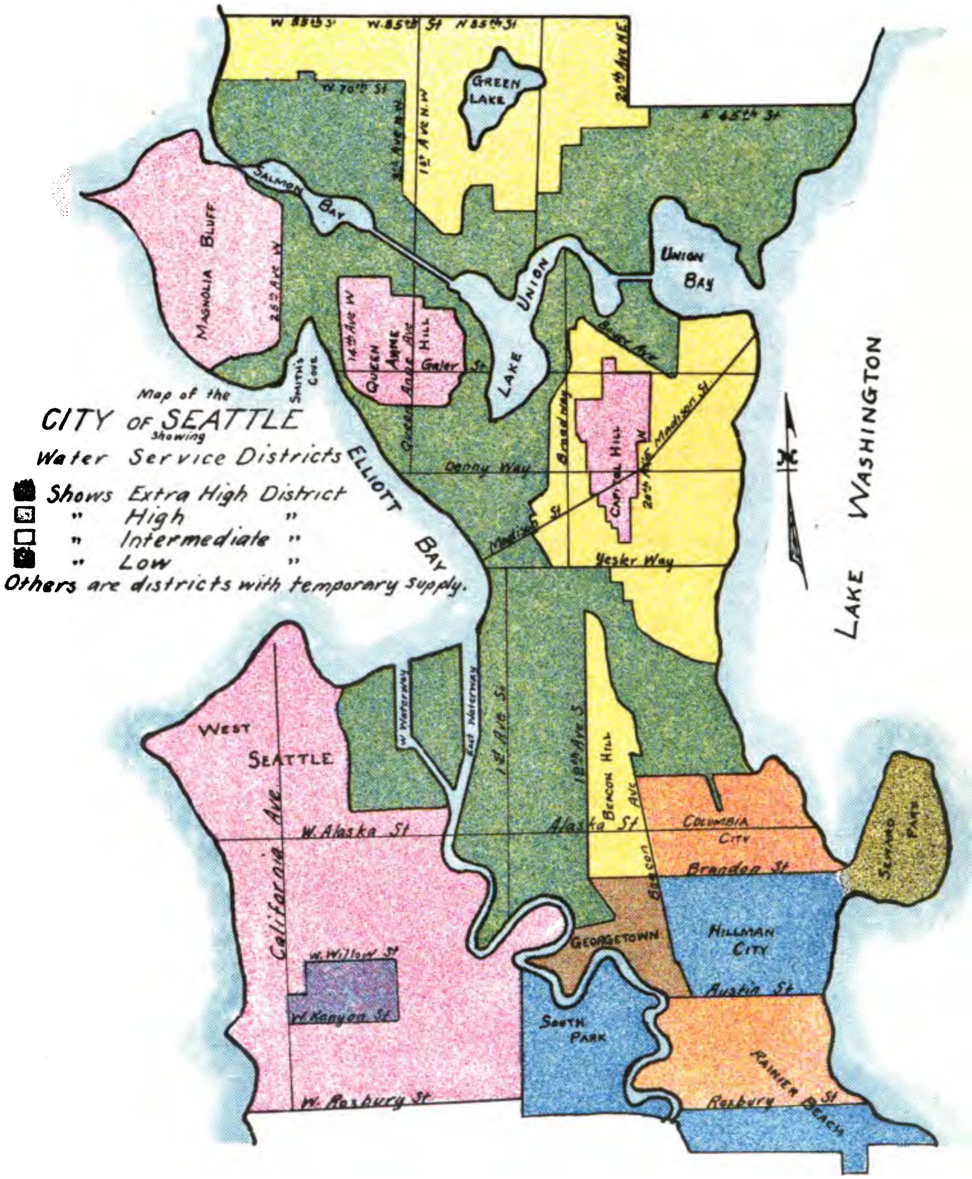
Pipe line delivers 5,969,000 cubic feet per day, which equals 248,-708 cubic feet per hour, which equals 4,145.1 cubic feet per minute, which equals 69.1 cubic feet per second.

$69.1 \div 14.466 = 4.8$ feet per second—velocity of flow in pipe line No. 2.

X

THE STORAGE SYSTEM

	Elevation, Ft.	Capacity in Gals.
Two new Beacon Hill reservoirs, low service	316	110,000,000
Green Lake, low service reservoir	316	50,000,000
Lincoln Park reservoir, low service	316	22,864,000
Green Lake intermediate service reservoir	420	60,000,000
Volunteer Park intermediate service reservoir	420	23,054,000
Ballard reservoir on 24th Avenue Northwest, between W. 73d and W. 75th Streets	247	1,000,000
Columbia City reservoir on 28th Avenue South and Hudson Street	335	100,000
Georgetown reservoir at the corner of Gould Avenue and Graham Street	278	250,000
Hillman tank at the corner of Beacon Avenue and Graham Street	331	50,000


Map of the
CITY OF SEATTLE
showing
Water Service Districts
Shows Extra High District
" High "
" Intermediate "
" Low "
Others are districts with temporary supply.
W. 85th St
W. 85th St
N 85th St
W. 70th St
Green Lake
20th Ave N.E.
E. 45th St
1st Ave N.W.
Salmon Bay
Magnolia Bluff
28th Ave W.
Union Bay
Lake Union
Queen Anne Hill
14th Ave W
Queen Anne Ave
Galer St
Smith's Cove
Elliott Bay
Denny Way
Broadway
Capitol Hill
20th Ave N
Madison St
Yesler Way
Lake Washington
West Seattle
California Ave.
W. Waterway
East Waterway
1st Ave S
12th Ave S
Beacon Hill Ave
Beacon
W. Alaska St
Alaska St
Columbia City
Brandon St
Seward Park
Georgetown
Hillman City
Austin St
W. Willow St
W. Kenyon St
South Park
Rainier Beach
Roxbury St
W. Roxbury St

Rainier Beach tank at the corner of Beacon Avenue and Gazelle Street	272	50,000
South Park tank at the corner of Beacon Avenue and Willow Street	278	50,000
Rainier Beach tank at the corner of Fountain Street and 51st Avenue South	395	50,000
West Seattle, 6 tanks at the corner of 40th Avenue Southwest and Charlestown Street, capacity of each tank, 50,000 gals.	468	300,000
Queen Anne Standpipe No. 1, high service	520	318,000
Queen Anne Standpipe No. 2, high service	520	883,000
Volunteer Park Standpipe, high service	520	883,000
Magnolia Bluff Standpipe, Grand Boulevard, between 38th and 39th Avenues West	470	250,000
Total		270,102,000

THE PUMPING SYSTEM

Lake Washington Steam Pumping Station. (For emergencies only.)
- One Holly pump, capacity, per 24 hours, ... 5,000,000 gallons
- One Dow Pump (of no value), original capacity per 24 hours .... 2,000,000 gallons
- Two Worthington pumps (of no value), original capacity per 24 hours .... 4,000,000 gallons
- Six tubular boilers
- Brick pump house
- Coal and oil house

Volunteer Park Electric Power Pumping Station. (For Volunteer Park Standpipe.)
- One 85 horsepower electrically driven centrifugal pump, capacity per 24 hours, 3,000,000 gallons; 12-inch suction, 10-inch discharge

Lincoln Park Water Power Pumping Station. (In regular use.)
(For Volunteer and Queen Anne Standpipe.)
- Two Gould's water driven pumps, capacity per 24 hours, 3,000,000 gallons

Queen Anne Steam Pumping Station. (Used in summer and for emergencies.)
- One Dow compound duplex pump, capacity per 24 hours, 3,000,000 gallons; 12 inch suction, 10 inch discharge. Two tubular boilers and frame pump house.

West Seattle Electric Power Pumping Station.
(In regular use to supply the 6 tanks.)
- One 150 horsepower electrically driven pump, capacity per 24 hours, 3,000,000 gallons; 12 inch suction, 10 inch discharge. One brick pump house.

Interbay Electric Power Pumping Station.
(Used to supply Magnolia Bluff.)
- One Worthington 2 stage centrifugal electric driven pump, capacity, 1,500,000 gallons per 24 hours, 8 inch suction, 6 inch discharge.

DISTRIBUTING ZONES

The distributing zones are three in number, as follows:

The Low Service District includes all parts of the city less than 225 feet above tidewater. This district is supplied by direct pressure from Lincoln Park, Green Lake and Beacon Hill Twin reservoirs, each having an overflow elevation of 316 feet.

The Intermediate Service District includes all parts of the city between 225 and 325 feet elevation above tidewater. This district is supplied by direct pressure from the Volunteer Park and Maple Leaf reservoirs, each having an overflow elevation of 420 feet.

The High Service District, which lies more than 325 feet above tidewater is supplied from the Queen Anne and Capitol Hill standpipes, which have an overflow elevation of 520 feet.

METHOD OF DELIVERY

The two old pumping stations, one at Lake Washington and one at Fourth Avenue North and Ward Street, are now out of regular use. They both remain available for use in case of emergency. The pump at Fourth Avenue North and Ward Street is used during the greater part of the dry season in summer.

The water from Cedar River is now delivered to Volunteer Park and Maple Leaf reservoirs direct, except a portion which is diverted from the pipe line into the new Beacon Hill reservoir. The elevation of the crest of the dam at the intake on Cedar River at Landsburg being 535.83 feet, gives a head into Volunteer Park and Maple Leaf reservoirs of 115.83 feet.

From Volunteer Park and Maple Leaf reservoirs enough water is delivered through the Intermediate Distributing system to supply the Intermediate District direct, and part is conveyed through a 3-foot pipe from Volunteer Park reservoir to Lincoln Park reservoir to drive the Lincoln Park pumps, and, after developing the power for the pumps, the water is used to supply the Low Service District direct. The electric pump at Volunteer Park sends water to the Volunteer Park standpipe, and the water driven pumps at Lincoln Park send it to both Queen Anne and Volunteer Park standpipes.

At the present time there are six districts which are temporarily supplied from tanks and reservoirs in the south end of the city. These tanks are all supplied from the main pipe line and furnish water to distributing systems that were constructed before these districts became a part of the city. They cover an area all told of about eight square miles. They are the

Columbia District—Reservoir elevation, feet	335
Hillman District—Tank elevation, feet	331
Georgetown District—Reservoir elevation, feet	278
South Park District—Tank elevation, feet	278
Atlantic City District—Tank elevation, feet	272
Rainier Beach District—Tank elevation, feet	395

Up to an elevation of 225 feet these districts will be supplied directly from mains connected with the Beacon Hill reservoir when trunk mains are extended into that territory. All of this territory having an elevation of more than 225 feet, possibly 250 feet, will be supplied from a standpipe directly connected with the pipe line to be built at or near Beacon Hill reservoir.

F. W. WALD

Operations of the Water Department for Two Years Previous to Jan. 1, 1892

The first detailed report of the operations of the Water Department was made by Superintendent F. W. Wald on December 31, 1891. As this report is comprehensive, and shows very clearly the condition of the plant and the territory supplied during the early period referred to the greater part of it is quoted.

Seattle, Wash., Dec. 31, 1891.

To the Board of Public Works of the City of Seattle.
Gentlemen:

I have the honor to present herewith the first general report of the City Water Department, up to and including December 31, 1891:

Amount paid Spring Hill Company for entire plant, $352,265.67.

NEW CONSTRUCTION

This account represents the cost of constructing the new system by the city, and forms the largest items of expenditures in this Department. It reaches back to December 23, 1889, or eleven months prior to November 1, 1890, the date on which the Spring Hill Company formally transferred its plant to the city. While work on construction commenced as early as December, 1889, being then done by the Spring Hill Company under direction of the former City Council, it was not prosecuted with vigor until after the formal transfer, November 1, 1890. Construction then began in earnest and was continued with unceasing activity until the approach of the present winter season, by which time the pipe on hand was nearly all laid.

PIPE LAID

Size	No. of Feet
4 in.	9,213
6 in.	70,992
8 in.	33,045
10 in.	5,724
12 in.	19,210
16 in.	7,992
20 in.	17,350
24 in.	5,750
30 in.	7,850
	177,126

or 33 miles and 2,886 feet = 33.545 miles.

Cost thereof	$276,187.81	
Cost of special castings	26,441.00	
Hydrants and water gates	25,662.57	
Cost of hauling	10.632.11	
Cost of labor as per pay roll	79,015.33	
Lead, yarn, nails, etc.	28,318.80	
Laying pipe smaller than 4 in	7,336.90	
		$453.594.52
Cost of Civil and Hydraulic engineering		35,795.12
Total		$489 389.64

NEW HYDRANTS

New hydrants set	277
Old Hydrants Set	70
Total	347

IMPROVEMENTS TO PUMPING STATIONS, INCREASING THEIR EFFICIENCY AND VALUE

LAKE WASHINGTON PUMPING STATION—		
Worthington Pump	$ 8,900.00	
Foundation	741.00	
Work	326.00	
Hauling	128.25	
Buildings	1,160.38	
Erection	147.00	
Special castings	2,117.27	
		$ 13,519.90
Three boilers	3,799.72	
Enlarging building	1,238.38	
Piling	135.00	
Heater	185.50	
Two scows	2,949.04	
		8,307.64
Total		$21,827.54
BROADWAY PUMPING STATION—		
One boiler	$1,575.00	
Pipe fitting	285.22	
Governors	189.13	
Worthington pump	765.00	
Lumber	145.94	
Special castings	108.72	
Sundry expenses setting up boiler, fitting, and repairing old plant	585.53	
Total		$3,654.54
LAKE UNION PUMPING STATION—		
Putting pumps in condition		$210.15
LAKE UNION PLANT—		
Bought from Lake Union Water Co. for	$ 27,500.00	$11,866.64
Paid on account	11,866.64	
Yet due	$15,633.36	
Tools for all departments	2,730.02	
New shop and house	370.54	
Office furniture:		
Desk, etc.	267.02	
Safe	400.00	
Total		$3,767.58
221 meters bought for city		7,874.31
Preparations to receive steam connections for Holly pump		56.31

OPERATING EXPENSES FROM NOVEMBER 1, 1890, TO JANUARY 1, 1892

1891	Lake Wash.	Broadway	Lake Union	Office	Oper. Mains
Prior to Nov. 1, 1890	$ 3,118.29	....	....	$ 250.95	$ 159.11
Nov., 1890	2,676.99	$ 397.20	....	1,173.08	129.06
Dec., 1890	2,307.24	360.86	....	534.00	131.30
Jan., 1891	2,987.48	425.95	....	723.43	179.62
Feb., 1891	2,424.08	457.40	....	771.44	381.64
March, 1891	2,447.13	416.01	....	742.55	426.78
April, 1891	3,174.51	596.98	....	482.75	361.66
May, 1891	2,935.72	473.99	....	469.50	371.79
June, 1891	2,325.39	481.02	....	589.34	329.03
July, 1891	3,408.59	522.65	....	465.00	400.63
Aug., 1891	2,505.17	660.83	$ 631.22	523.18	396.08
Sept., 1891	2,411.90	514.78	410.14	404.61	157.31
Oct., 1891	2,559.55	691.22	450.55	452.30	601.87
Nov., 1891	2,297.99	576.66	305.33	409.56	680.17
Dec., 1891	2,611.85	694.55	248.17	517.47	421.25
	$40,191.88	$7,270.10	$2,045.41	$8,509.16	$5,127.30
	1,915.22				
Total	$42,107.10				
Credit	7.50	7.65	....	....	72.00
Net	$42,099.60	$7,262.45	$2,045.41	$8,509.16	$5,055.30

RECAPITULATION OF TOTALS

Operation Lake Washington	$42,099.60	
Operation Broadway	7,262.45	
Operation Lake Union	2,045.41	
Office	8,509.16	
Operation Mains	5,055.30	
Domestic Service	314.71	
		$65,286.63
Monthly average, fourteen months	$4,670.47	

MONTHLY REPORT IN GALLONS OF WATER PUMPED

	Gallons	
November, 1890	126,456,103	
December, 1890	126,456,103	
January, 1891	126,456,103	
February, 1891	115,307,004	
March, 1891	125,297,991	
April, 1891	124,132,091	
May, 1891	126,591,540	
June, 1891	140,425,855	
July, 1891	151,557,687	
August, 1891	159,805,501	
September, 1891	129,322,600	
October, 1891	124,251,782	
November, 1891	141,883,200	
December, 1891	153,156,200	
		1,871,099,760
Monthly average	133.649.983	
Daily average	4,454,999	
Pumped per capita for 50,000 population, daily average		89 gals.

MONTHLY METER RECORD

		Gals.	Amts. Recd.
November,	1890	14,128,360	$ 2,790.35
December,	1890	14,548,615	2,946.50
January,	1891	13,977,068	2,674.70
February,	1891	14,287,814	2,931.60
March,	1891	16,784,574	2,960.90
April,	1891	19,071,946	3,105.10
May,	1891	20,354,018	3,109.30
June,	1891	25,610,250	3,944.95
July,	1891	24,606,794	3,767.50
August,	1891	24,303,725	3,916.10
September,	1891	23,908,702	3,600.65
October,	1891	24,342,830	3,848.85
November,	1891	24,731,125	3,984.00
December,	1891	22,703,562	3,667.05
Total			$47,247.55
Average receipts per 1,000 gals.			$0.16674

MONTHLY REPORT ON TAPS MADE AND REVENUE RECEIVED THEREFOR

		No. of Taps	Amts. Recd.
November,	1890	21	$ 256.50
December,	1890	31	585.00
January,	1891	20	224.50
February,	1891	17	288.00
March,	1891	28	421.65
April,	1891	49	735.00
May,	1891	43	441.60
June,	1891	69	997.40
July,	1891	70	766.00
August,	1891	60	721.75
September,	1891	35	411.46
October,	1891	59	524.00
November,	1891	36	318.00
December,	1891	39	250.00
		577	$6,940.86

MONTHLY WATER RECEIPTS IN CASH

November,	1890	$ 6,034.20	
December,	1890	9,967.05	
January,	1891	10,912.74	
February,	1891	10,492.15	
March,	1891	9,877.75	
April,	1891	10,704.47	
May,	1891	10,698.25	
June,	1891	10.499.26	
July,	1891	10,846.03	
August,	1891	10,414.19	
September,	1891	10,792.39	
October,	1891	11,172.78	
November,	1891	10,234.14	
December,	1891	11,285.85	
			$143,981.26
Water furnished Fire Department		$10,822.50	
Water furnished other city property		407.76	
			$11,230.26

RECAPITULATION

Cash receipts	$143,981.26	
City property	11,230.26	
Total		$155,211.52
Monthly average receipts for 14 months		11,086.53

REVIEW OF EARNINGS AND DISBURSEMENTS

Total revenue		$155,211.52	
Interest	$59,458.54		
Discount	1,267.50		
Operation		126,020.32	
Net profit			$29,191.20

It is not out of place to say that this department has paid interest on $845,000, bonded indebtedness, for four months prior to November 1, 1890, or prior to the time revenue was derived from the plant. Estimating this four months' loss in operation on the proportionate and actual basis of expense, as per fourteen months' operation, namely $4,670.47 per month, together with the actual proportion of interest and discount on sale of bonds, and taking the average fourteen months' monthly revenue at 10 per cent reduction in order to be safe, we arrive at the following:

Revenue for 4 months at $11,086.53	$ 44,346.12	
Less 10%	4,431.61	
Net		$39,911.51
DISBURSEMENTS—		
4 months' operation at $4,670.47	$18,681.78	
4 months' interest on $845,000	14,083.33	
4 months' proportion of discount	281.67	
Total		$33,046.78
Net Gain		6,864.73
Adding this to actual cash profits as per ledger	$29,191.20	
	6,864.73	
Makes a total of		$36,055.93

which sum approximately, would be the showing of net profit at this date had the City's earnings began simultaneously with the payment of interest.

Number of ledger accounts to date 2,414

FINAL TRIAL BALANCE

Civil Engineering	$ 35,795.12	
City property	264.20	
Fire Department	18,151.57	
Fire boat	56,351.99	
Spring Hill plant	352,265.67	
Lake Union plant	11,866.64	
Construction	466,845.31	
Tools	2,701.86	
Lake Washington Station improvements	18,878.50	
Scows	2,949.04	
Broadway Station improvements	3,654.54	
New shop and house	398.70	
Unearned discount	15,632.50	
Bonded indebtedness		$845,000.00
City Treasurer		121,532.64

Street Department	82.90	
Lake Union improvements	210.15	
Office fixtures	667.02	
Meters	7,829.31	
Sewer Department	1,122.51	
New Holly pump	56.31	
Profit and Loss		29,191.20
Total	$995,723.84	$995,723.84

SIZE, KIND AND NUMBER OF FEET OF PIPE IN USE DECEMBER, 1891

Size	Wrought	Cast	Total No. of Ft.
1 in.	1,370	....	1,370
1½ in.	2,780	....	2,780
2 in.	75,635	....	75,635
4 in.	16,675	....	16,675
6 in.	18,225	64,750	82,975
8 in.	30,300	26,500	56,800
10 in.	1,325	7,650	8,975
12 in.	32,900	9,675	42,575
16 in.	....	7,850	7,850
20 in.	....	17,350	17,350
24 in.	....	5,750	5,750
30 in.	....	7,850	7,850
Total	179,210	147,375	326,585
In miles 2 in. and under		15 miles	585 ft.
In miles 4 in. and over		46 miles	3,920 ft.
Total		61 miles	4,505 ft.

To complete the present system, when the work now in hand is carried out, namely, the installation of the new Holly pump, suction pipe thereto and force main therefrom, and the pipe on the bark Thomas Dana, now at our dock unloading, is placed in position, this Department will be in shape to pay for any normal and legitimate increase for additional water supply out of its earnings. But it cannot be expected to pay out of its earnings the amount necessary to complete the portion as yet uncompleted; provision therefor must be made in some other way.

ESTIMATE OF COST

To complete the work now in hand, contracts for which have been made and authorized by the Honorable City Council:

New Queen Anne Pumping Station	$ 2,665.00	
Contract price for Holly pump	36,600.00	
Suction inlet pipe and well	6,310.00	
7,400 ft. 20 in. force main	35,000.00	
Invoice cost of pipe on Thomas Dana	44,561.33	
Estimated cost of laying same	86,342.12	
		$211,378.45
To this add amount due Lake Union Water Co. on plant		15,633.36
Outstanding warrants of water office as per Comptroller's statement furnished me		12,480.34
Total		$239,492.15

Which amount, as hereinbefore stated, is necessary to complete the present system, and which after it is provided for by bonding so as to give the city the benefit of a minimum interest rate, will place the Department upon its feet and on a basis of self sustenance, and put it on the road to yield greater revenue. Even the present showing to date is a guarantee that the plant will leave a profit on and above all interest and expenses. Were bonds for above amount already issued at the same rate as the $845,-000 bonded indebtedness, as on the present showing with one year's interest at 5 per cent paid on this above named amount, it would now leave a net profit of $17,404.53, and there is no question in my mind that the future revenue will far exceed our past record. The Water Department should be reimbursed for the amount paid for the fire boat, and interest thereon, a total of $56,351.99. The receipt of this $56,351.99 would decrease the amount estimated above for cost of work now on hand to $183,148.16.

The operating expenses so far as fuel is concerned should be reduced the coming year, because the Holly Manufacturing Company are under contract to pump as much water with one ton of coal as the present pumping engines in the Lake Washington Pumping Station pump with two tons of coal. The average cost of fuel per month has been $1,488.23. One-half of this, $744.13 per month, means an annual saving of $8,929.56.

In conclusion, I would say that any new enterprise meets with its heaviest expenditures at the start. It has been so in this Department. There are many items of expense the Department had to incur which will bear revenue in future operations. The yield of the Department can so far only be considered as nominal, and as the city grows and population densifies in districts as yet sparsely settled and through which our mains had to be laid in order to furnish a general supply, the revenue will show a satisfactory and constant increase. Respectfully submitted,

F. W. WALD,

Superintendent.

The situation of the Water Department and the questions confronting it in 1892 are well set forth in the report issued for that year by Superintendent W. E. Wilson. I quote quite fully from this report in order that the record of these early transactions and recommendations may be preserved in their more important features.

This report issued on January 28, 1893, shows that there was then invested in the water plant the sum of $1,045,521.84.

The earnings of the plant during 1892 were	$142,321.91
Sale of bonds	200,971.34
All other sources	3,670.51
Total collections	$346,963.76
The disbursements were	306,344.78
Unexpended surplus	40,618.98

The text of Mr. Wilson's report follows, exclusive of the tables:

Rock Slide in Watershed

Our Future Water System

Four years ago the citizens of Seattle decided, by almost unanimous vote, that the city should own and operate its own water system. The first step in this direction was the purchase in 1890, of the plant and franchises of the Spring Hill Water Company. Recognizing that Lake Washington could not permanently remain the source of the city water supply, exhaustive surveys were made under the direction of an engineer of national reputation, Mr. Benezette Williams of Chicago, and a complete plan devised for conducting the water from a point on Cedar River, in the mountains, above all possible sources of contamination, to an immense storage reservoir at Swan Lake, thence by a 42-inch aqueduct to supply by gravity two reservoirs in the city, one to be 15,000,000 gallons capacity, on Beacon Hill, serving the low service district below 200 feet elevation, the other 10,000,000 gallons capacity, in the City Park, to serve the higher districts between the elevations of 200 and 350 feet. A small district above 350 feet would remain to be supplied by high pressure from a small pumping station near the City Park reservoir. The city was not strong enough financially at that time to carry the plan to execution, and has therefore continued the use of the Lake Washington water, increasing the pumping facilities as necessity demanded. The quality of water was decidedly improved by the introduction of a better method of taking the water into the suction pipes, at a greater distance from shore and a depth considerably below the surface. Many miles of distributing mains have been laid throughout the city, following the plan to be part of a permanent gravity system.

The period has now been reached in the history of the Seattle city water system when it is our duty, as a measure of economy—to say nothing of health—to compare the cost of the present pumping system, and keep it up to the city's necessities, with the construction of the ultimate gravity sytem.

The Seattle city waterworks has proved such a good investment, and is showing up such large monthly balances of profits, that many of our people have grown to consider the "water problem" of Seattle as settled, instead of postponed. The fact is, that we are fast approaching a period when increased expenses of pumping will exceed the interest charges on a permanent gravity system. Already we have reached that stage when every dollar spent in increasing pumping capacity is a dead loss so far as the permanent system is concerned. The Water Department is today doing business with a reserve capacity insufficient to meet present demands, should the new Holly pump break down. The entire district supplied by high pressure from Broadway Station would experience a decidedly dry season if either of the old Spring Hill pumps should give way. The present average consumption is 6,200,000 gallons daily. At a moderate estimate,

this average will have increased by December, 1893, to 7,500,000 gallons. It must be remembered that we are practically without sewers in nine-tenths of our residence districts. When this necessity is met, the consumption of water will be enormously increased. To provide a safe reserve for necessity in case of a breakdown, as well as to meet the increased demands of the coming year, it is imperative that a pump of at least 6,000,000 gallons daily capacity be provided as speedily as possible. Such a pump, in place, will cost about $40,000, and the interest on this additional cost, added to the estimated expenses for pumping in 1893, will make a total of $52,000 per year, or the equivalent of 5 per cent interest on $1,050,000. The present reservoir capacity on Beacon Hill is about 4,000,000 gallons. The gravity system demands in that locality a reservoir of 15,000,000 gallons capacity. It is evident that such an increase can never be made on the present site, as, even if the walls could be built up to include the increased capacity, it would be a perpetual menace to all property in the vicinity to have such an immense volume of water stored on the area of a single block. The needs of 1893 demand increased reservoir capacity as soon as possible. In providing for the present, should we not do the work along permanent lines? It is probable that the fractional block of six lots north and the full block of twelve lots south of the present site could be purchased from funds realized from sale of some of the scattered lots at present belonging to the Water Department, or possibly might be exchanged for such lots. With these blocks added to the present reservoir site, with Pine Street and Plum Street vacated between South Sixteenth and South Fifteenth, we would have an unbroken area of 835x256 feet, or about five acres. The cost of excavation and construction of a reservoir of 15,000,000 gallons capacity upon such a site would be about $75,000. It would be arranged for two independent basins, so that part could be cleansed without affecting the supply to the city, also affording a constant reserve in case of breakage of large mains leading from either basin. Taking into consideration that some increase of capacity must be speedily provided, would it not be wise to at once secure the grounds and spend the necessary funds in a permanent reservoir?

Looking ahead another year beyond the present—and such foresight is certainly wisdom—it is certain that by December, 1894, the average daily consumption will amount to at least 11,000,000 gallons, for, by that time the increase, by reason of sewerage and heavy manufacture, will largely swell the necessities for water. Unless the construction of the gravity system is sufficiently under way to guarantee the supply of the city for 1895, it will be necessary before December, 1894, to still further increase the pumping capacity by at least 10,000,000 gallons, in order to keep a safe reserve. This will make a further expense of $80,000 for pumps, and at least $120,000 additional for entire remodeling of engine and boiler rooms and construction of new mains, or including the cost of the pump to be purchased this year, a total of $240,000 will be required for

additional pumping facilities and mains before December, 1894. Interest on this amount, added to the operation expenses incident to a pumping plant, will by that time amount to $92,000 per annum, which is 5 per cent interest on $1,850,000, an amount far in excess of the total needed to complete a permanent gravity supply from Cedar River. Estimated on the basis of the high rates for labor and material ruling in 1890, Mr. Williams placed the cost of the dam at Cedar River, conduit to Swan Lake, arrangement of the lake as a storage reservoir, aqueduct from Swan Lake to Seattle, and a 10,000,000 gallon reservoir in the City Park, all ready for delivering the clear mountain water into our distributing system, at a total of $1,200,793. Add to this the $75,000 necessary ror increasing the Beacon Hill reservoir and sufficient additional to provide reserve mains from the various reservoirs, and to provide for all contingencies, as a safe estimate $1,450,000 will complete the gravity system, with capacity sufficient to supply the city without further expense, up to a limit of 250,000 population.

To summarize the situation briefly, the City of Seattle is at present conducting a water system with constantly increasing demands, but without sufficient reserve in case ot break downs or accidents. To keep pace with the necessities of the city by a pumping system, we shall be compelled to make continued expensive additions to the plant, and by December 31, 1894, we shall be paying for fixed annual expenses necessary with a pumping system $20,000 more per annum than 5 per cent interest would amount to on bonds which would yield sufficient to build the gravity system complete. If we are compelled to continue pumping after that date, the disproportion against the pumping system will increase at the rate of $10,000 annually. If the Cedar River gravity system is to be our permanent supply—and health, as well as economy demands that it should be—every dollar now spent in increasing our pumping capacity is lost, so far as the future is concerned. After December 31, 1894, it will cost more to pump water from Lake Washington than to pay interest on a completed aqueduct and reservoirs to supply Cedar River water by gravity.

In considering the plan of permanent water supply it should not be overlooked that there will be sufficient power in the waste of water from the Swan Lake storage reservoir to generate, at nominal expense, sufficient electricity to furnish the city with light and power for every purpose. This of itself would be a saving of many thousands of dollars annually, and a source of a large income.

I have gone into this question thoroughly, because I consider it a problem to be settled within the next three months. To maintain the lowest insurance rates for business protection, our supply must exceed the demand with a safe reserve. The gravity system is the most economical plan to secure this result, both for the present and future. To complete the system before 1895, construction should commence the coming summer, and no further expense (beyond the one pump now needed) would be necessary

for increasing our pumping facilities. The annual receipts of the Department for 1892 were $163,715.40, With an unlimited gravity supply to draw from the increase of population and extension of service, would, if present rates are maintained, swell the receipts to $275,000 per annum by 1895. The present bonded indebtedness for water purposes is $1,050,-000. Should new bonds be issued to the extent of $1,450,000, making a total of $2,500,000 bonded indebtedness of the Water Department, the total interest at 5 per cent per annum will be $125,000. The total annual office and operating expense and necessary repairs would be not to exceed $35,000, thus leaving a margin of $115,000 per annum for extension of the distributing system and establishment of a sinking fund. As the years continue the receipts of the gravity system would increase in proportion to population, while the expense of operation and repairs would be but slightly larger, leaving each year a greater margin for the sinking fund and for extensions.

With the present necessity for providing employment for hundreds of laborers, with rates for materials and labor which will probably never again be equalled, I trust that this question of the future of our city water system, involving such great results in economy and health, will receive your most careful consideration.

A PROPOSED RE-ADJUSTMENT OF THE FINANCIAL STATUS OF THE CITY WATER WORKS SYSTEM

The wisdom and economy of an immediate move in the direction of a permanent gravity system has been previously shown. I desire also, at this time, to call attention to a few of the inequalities in our present financial support of the city water system, and to make some suggestions in the line of a more equitable division of burdens.

An examination of the balance sheet of the Department for 1892 will show that in addition to their regular city and county taxes, a limited number of our citizens have, under the name of "water rates," carried the entire burden of $1,050,000 of the bonded indebtedness, paid every item of expense for maintenance, repairs and operation of the entire system, furnished water to the value of $24,544 for use by every department of the city, including the parks, sewers, hydrants, etc., and have also contributed over $40,000 for extension of the water system to new districts, or for uses entirely outside of the Water Department. The injustice of such a special tax on part of the people for the benefit of all needs no argument to be proven. The question is, How can the city, especially at a time when a great expenditure is urged to construct the gravity system, make any re-adjustment which shall involve such a reduction of revenue?

I beg leave to suggest a plan by which our present rates to consumers can be cut down at least one-third, the general burden of water taxation

equally distributed, and at the same time yield sufficient revenue to pay all expenses of operation and maintenance, meet the interest on present indebtedness and $1,450,000 additional for immediate construction of the gravity system, and extend the water service within five years to every settled district within the city limits.

Thus far our financial policy has been based on the theory that the consumer, or ratepayer, is the only person benefited by a water supply, but this is far from being a true view of the case. Our city limits include about 18,000 acres of land, while our water system extends over only about 4,000 acres, less than one-fourth of the total area. Every acre of land within the city limits has a higher value by reason of the fact that the city owns a water supply capable of extension over the entire area, as rapidly as means will justify. Every insurance rate in the city is lower by reason of the adequate fire protection, made possible by hundreds of hydrants, maintained with constant pressure and supply. If this is true with our present inadequate pumping system, it will be pre-eminently applicable when we are assured of an unlimited supply of clear mountain water, flowing directly into our reservoirs from the head waters of Cedar River. Every foot of real estate within our municipal limits will feel the impulse of prosperity which will come with the ownership and extension of such a system.

By our present plan not a dollar's cost for construction, maintenance, or interest is paid by the owners of more than three-fourths of the area of the city, nor will they pay anything until they choose to improve their property and become consumers. Resident or non-resident speculators can, under present conditions, hold large unplatted tracts or unimproved "additions," around or through which water mains are extended to serve improved districts beyond, and, at their own sweet will, for a fancy price made possible by improvements to which they have contributed no share of tax, sell to some bona fide resident, who thereupon improves the property, becomes a consumer, and thus assumes a share of the responsibility of cost. For instance, ever since the city owned the system, and several years before, a main has been in service extending along Jackson Street through the so-called "Hill Tract," through which water is furnished to the residents east of Wilfred Street. From the day of its construction, the Spring Hill Water Company, and for the past three years, the City of Seattle—or rather a portion of the taxpayers of Seattle—have maintained high pressure pumps at Broadway Station, forcing water across this more than one-half mile of unproductive property to consumers beyond, without receiving one dollar income from the owners of that property, nor have they carried any portion of the city debt, incurred for purchasing that pipe, or maintaining the system. Yet every lot in that vicinity will sell for at least 20 per cent more by reason of the convenient water service, and insurance rates will be proportionately cheaper as a result of the hydrants and fire protection, paid for by the water consumers in the other portions of the city. At the present time the people of Fremont, Denny-Fuhrman Addition, Latona, Brooklyn,

Madrona Park vicinity, and other outlying districts, are calling for extensions of the water system for domestic service and fire protection. They have just reason to expect such service, but under the present financial status of the Water Department every one of these lines would be a repetition of the instance cited with reference to the "Hill Tract," *i. e.*, long unproductive water mains, built by present consumers, maintained by present consumers, interest on entire water supply paid by present consumers, while intervening real estate owners, frequently non-residents, reap the benefits of increased valuations, while assuming no share of cost or responsibility.

The situation resolves itself into this: Less than one-fourth of the taxable area of the city is carrying a burden which should be distributed equally over the entire area. In addition to ordinary taxes, every consumer within the city limits should pay for three items of expense incident to the water system:

First—His share of the expense of maintenance and repairs.

Second—His share of interest on bonds which realized the cost of construction.

Third—His share of a tax necessary to provide a sinking fund for redemption of bonds.

Owners of real estate not improved or not paying water rates as consumers, should pay their share of the cost of extensions to provide them with service, and their portion of the interest on the bonds which made the water supply available. The same principle which governs taxation for electric lighting, fire protection and the general sewer system applies with even greater force to the general burden of construction and extension of our water system. It is proper that consumers only should pay for maintenance and operation, but beyond this the responsibility should be equally shared. The present plan is on the same principle as it would be to ask a man to furnish capital to set his neighbor up in business—a good policy for a philanthropist, but foreign to all just principles of taxation.

In my opinion a "general water tax" assessed equally by area, over the entire city, is the fairest readjustment of our water department finances. Assessment by valuation would be manifestly unfair, as the cheapest lots represent usually the greatest expenditure to reach with water service. The result aimed at is to place an adequate water main in front of every lot in the city, and this represents approximately an equal interest in the supply, plant and distributing system for every front foot, regardless of valuation, a uniform rate of three (.03) cents per annum for every 100 square feet (equivalent to three cents per front foot for lots 100 feet deep) would be amply sufficient for all purposes, yielding to the city a revenue of about $125,000 per annum, deducting all property of the city, county and state from the effects of the tax. Such a minimum rate may seem almost insignificant in results, but it would work wondrous improvements. Actual consumers would pay in addition to the general water tax about two-thirds of the present rates. Thus, a householder with a lot 50

feet by 100 feet would pay a "general water tax" of $1.50 per annum, while his water rate would be reduced from $15.00 ($1.25 per month) to $10.00 per annum—a net saving of $3.50 per annum. In spite of the reduction in revenue from consumers the total income, added to this "general water tax" would be sufficient, first, to pay all expenses of maintenance, operation and repairs; second, to pay five per cent interest on present bonds and $1,450,000 additional for immediate construction of the Cedar River gravity system; third, provide at least $1,000,000 per annum for extensions during the next five years to every portion of the city; fourth, within the next fifteen years after that time, accumulate sufficient sinking fund to redeem the entire issue of water bonds, both old and new, $2,500,000 in all. These figures are made on the basis of the balance sheet for 1892.

Presuming that such a "general water tax" of three cents per annum for every 100 square feet is assured, the water rates cut down one-third, and $1,450,000 bonds issued to construct the gravity system, the following would be the approximate financial statement for 1893:

Receipts from water rents	$140,000.00
Receipts from general water tax	125,000.00
Total receipts	$265,000.00
Expenditures for maintenance, operation, etc.	60,000.00
Expenditures for one year's interest on $1,050,000	52,500.00
Expenditures for six months' interest on $1,450,000	36,250.00
Available for extensions to new districts	116,250.00
Total expenditures	$265,000.00

In 1894, by reason of increased expenses for pumping, and a full year's interest on the new bonds (partially offset by increased income resulting from extension of system), the amount available for extensions would be about $80,000, after paying all expenses and interest. In 1895, with the gravity system completed and in service, the reduced expenses of operation and the increased income from new consumers, would produce a financial statement approximately as follows:

Receipts from water rents (two-thirds present rates)	$200,000.00
Receipts from general water tax	125,000.00
Total receipts for 1895	$325,000.00
Expenditures for maintenance, operation, etc.	$ 35,000.00
Expenditures for interest on $2,500,000 bonds	125,000.00
Available for extensions to system	165,000.00
Total expenditures	$325,000.00

Every subsequent year the receipts from water rents would increase in proportion to the new consumers reached by extensions, while the cost of operation of the gravity system would increase in slight proportion. This steady increase would continue up to the time when a population of about

200,000 is attained, when it would again be necessary to make additions to the general supply system. Should that population be attained by the year 1910, the total receipts from water rents and general water tax, over and above all expenses of operation, maintenance, repairs and interest on the bonds during the entire period, will amount to the gross sum of $4,000,000, by reason of the steady increase above referred to. This would allow the expenditure of $1,500,000 for extensions to the distribution system as needed, and still leave $2,500,000 of a sinking fund, sufficient to redeem all the water bonds. With such results achieved the "general water tax" could be suspended, and the rates still further reduced to the actual cost of maintenance, renewal and extensions to the distributing system and sources of supply.

The "general water tax" of three (.03) cents per 100 square feet per annum, will make it possible to secure the results above named, if the gravity system is built at once, at the same time dividing the responsibility equally. A uniform rate by square feet of area, instead of by front footage, makes it possible to assess platted lots of varying sizes, and unplatted tracts, in an equitable manner. Such a tax, accompanied by a fair reduction in present water rates, would be satisfactory to every present consumer. It would meet the approbation of every actual resident and lot owner in districts not now served, who would gladly pay an annual tax averaging $1 to $2 per annum, according to size of lot, if assured that such a policy would result in an extension of the water service to their districts in the immediate future. It would receive the opposition only of owners of large tracts of unimproved or unplatted property, mostly of non-residents, who would thus be forced to pay their share towards the support of a system which makes their property valuable and salable. It would help to force many of such owners, now blocking the path of progress, to plat their property in suitable shape, and to dispose of it to actual residents, who will make improvements—surely, "a consummation devoutly to be wished for."

These figures, statements and estimates are well on the safe side, and can be strongly substantiated. It is my firm conviction that if we levy this light general tax, reduce the water rates, issue new bonds to the amount of $1,450,000, and construct this gravity system at once, besides doing justice to present consumers, we shall be adopting a policy which will pay all expenses and interest, extend the system throughout our city limits within five years, and so add to the receipts that before twenty years every bonded obligation will have been met and the city be in possession of a complete water system, free from debt, and a perpetual source of income.

Respectfully submitted,

W. E. WILSON,

Superintendent.

The Second Bond Issue

The second issue of bonds was authorized by a three-fifths' vote of the electors at the election in the spring of 1892. The call for this election was made by Ordinance No. 1971, approved February 2, 1892, and proposed an issue of $205,000 in bonds to cover the following items as set forth in the call:

Holly pump	$36,500.00
Suction inlet pipe and well	6,300.00
New force main Lake Washington Station to reservoir	35,000.00
Final payment on Union Water Co.'s plant	5,633.36
Pumping Station for Queen Anne District	2,665.00
Invoice price of pipe on board "Thomas Dana"	44,561.33
Cost of laying pipe	84,340.31
Total	$215,000.00

The amount of the bonds for some reason was made $10,000 less than the estimated requirements. Ordinance No. 1971 also created an interest and sinking fund for these bonds—the sinking fund to begin just seven years before their maturity. The proposal to issue was carried by a three-fifths' vote and the bonds were issued July 1, 1892. The rate of interest was five per cent per annum.

On December 27, 1895, the Mayor approved Ordinance No. 4045, which authorized the condemnation of lands and right-of-way for Cedar River Supply System as outlined in Ordinance No. 3990. This ordinance designated the route of conveyance for the water, which was laid down in the plans of Benezette Williams and appropriated $1,000 to pay locating and court expenses. It also described the work to be done as Mr. Williams had planned it, instead of the way in which it was finally executed.

In January, 1895, a large tract of land on the side hill between the west margin of Thirtieth Avenue South and Lake Washington, and extending north and south from Dearborn to Norman streets, slid toward the lake, carrying away the 16-inch cast iron main on Thirtieth Avenue South. On February 5th Ordinance No. 3671 was approved authorizing the Board of Public Works to renew this main from the intersection of Thirtieth Avenue South west along Norman Street to Yakima Avenue and thence two blocks north on Yakima to Dearborn, where a new connection was made with the 16-inch main on Thirtieth Avenue South. The break did not cause any inconvenience, as the territory tributary to this main was supplied during the interval by feeding back through the Yesler Avenue main from Broadway Pumping Station.

Snow Scene in Watershed

THE CEDAR RIVER WATER SUPPLY

After the people had authorized the issue of bonds to the amount of $1,000,000 for the construction of the Cedar River Water System, it was found that issue would be in excess of the debt limit fixed by the State Constitution. General city bonds to the required amount could not, therefore, be issued. During the early nineties there was great business depression throughout the country, and Seattle suffered in common with every other city. The need of constructing the Cedar River System was fully recognized, but no means seemed to be available for the purpose. Finally in the spring of the year 1895 the joint committee of the Board of Aldermen and the House of Delegates were instructed to make an investigation with reference to the acquirement of the Cedar River water supply, and, after months of investigation, that committee made a report on October 7, 1895, which explains so fully the legal and financial conditions involved in the project that I give it here in full as an excellent historic statement of the situation at that time:

SPECIAL REPORT

JOINT FIRE AND WATER COMMITTEE

Seattle, Wash., October 7, 1895.

Mr. President:

The Joint Committee on Fire and Water begs leave to present the following special report and recommendations relating to the acquirement of the permanent Cedar River water supply and the extension of the city water works system.

The subject matter of this report has been under careful consideration for many months. Your committee have recognized the fact that upon the acquirement of this permanent water supply depends to a large degree the future of the municipality. At the outset of our investigations we found the question apparently hemmed in by insurmountable financial barriers. With a bonded debt reaching the maximum legal limit, it seemed hopeless to even speculate upon a project which involved the expenditure of nearly a million and a quarter dollars. The necessities of the case, the far-reaching injury which must result from continued non-action and the great benefits to be achieved by a successful solution of the problem, have made it a matter of public duty to exhaust every resource of investigation and consultation before surrendering the field.

It is unnecessary that this formal report should recount the progress of these investigations or the various expedients which have been considered in the hope of securing the desired result. Suffice it to say that it is our

privilege at this time to report and recommend a plan by which the City of Seattle can at once proceed to acquire the Cedar River supply, construct the gravity system, and within two years deliver the pure mountain water into the city distribution mains. This result can be accomplished without increase of the city debt, by a simple process of pledging for about fifteen years a fixed percentage of the current water receipts for the liquidation of the obligations incurred.

The experience of our sister city of Spokane in a more extreme situation, has furnished us with the key to the solution of our own water problem. About two years ago that city raised $500,000 by issuing bonds for the purpose of constructing certain extensions and additions to the city water works. A contract was let for the work and partial payments made as it progressed. In the meantime a large part of the money realized from the bond issue was lost to the city by the insolvency of the banks in which it had been deposited. The contractor continued work until he held warrants to the amount of $128,154.94, to meet which the city treasurer had no funds. Hence the contractor was forced to suspend work and the city was in a situation where heroic measures had to be resorted to or disaster was imminent. Their bond issues had already reached the maximum debt limit and no relief was to be had in that direction. To complicate matters still further, it was evident that the water works extensions would require a greater outlay than originally contemplated. In this emergency a proposition was made to the city offering an advance of $300,000 for the redemption of outstanding warrants and the completion of the work, provided sixty (60) per cent of the revenues of the city water works after July 1, 1895, be set aside in a special fund and applied only for the repayment of the advance so made, and also that any moneys recovered from the insolvent banks be similarly applied. This offer was accepted and by Ordinance No. A583 of the City of Spokane a contract was authorized to be entered into in accordance with said proposition. A certified copy of said ordinance is submitted herewith. Summarizing the conditions embodied in the contract authorized, we note that in consideration of the advance of the necessary amount, not exceeding $300,000, the city bound itself:

(a) To repay with interest all moneys advanced from the revenues received from its water works system.

(b) To set aside after July 1, 1895, sixty (60) per centum of all revenues acquired from the present or any other water works system of the city, into a special fund to be known as "Water Works Fund," to be used for no other purpose except the repayment of said money advanced, with interest (water used for municipal purposes not to be accounted).

(c) To deliver to the parties making the advance, warrants of a prescribed form, in denominations of $1,000 each, to the amount of said advance, bearing interest at eight (8) per cent per annum, payable semi-annually, interest and principal payable from the special Water Works Fund.

(d) Not to sell, lease or dispose of the water works system until the obligations above described are paid in full, or in case of sale or disposal to pay from moneys so derived all obligations then unpaid.

(e) Not to reduce the rates or charge for water so that sixty (60) per centum of the gross revenues shall amount to less than at present, until such obligations have been discharged.

(f) To apply to the payment of said obligations all moneys recovered from amounts previously appropriated for the extension of the water-works system.

The entire contract was made contingent upon the Supreme Court approving its validity.

The ordinance was passed June 7, 1895. It was vetoed by the Mayor June 15, 1895, and passed over the Mayor's veto on June 18, 1895. The validity of the ordinance and contract was attacked in a suit brought by Patrick H. Winston, suing on behalf of himself and others similarly situated, versus The City of Spokane. The Superior Court found the ordinance to be invalid on the ground that the existing indebtedness of the City of Spokane was in excess of the legal limit. The case was carried to the Supreme Court and on August 22, 1895, a decision was handed down reversing the Superior Court decision and approving the validity of the ordinance and contract. A certified copy of the Supreme Court decision is submitted herewith. The point of the decision is that "the transaction is no more the incurring of an indebtedness on the part of the city, than is the issue of warrants payable out of a special fund created by an assessment upon property to be benefited by a local improvement." This point has been frequently adjudicated upon, and in this respect the decision is simply in line with long established precedents.

During the last month, since the rendering of the decision of the Supreme Court, the authorities of Spokane have entered into the contract for the advance of funds, the money for the payment of outstanding warrants has been furnished and the warrants paid and work on the suspended contract has been resumed with funds at hand to meet all further expenses.

Through the open door found by our sister city, the way is clear for Seattle to take an advance step and acquire the Cedar River water supply. Under this decision we can create a special fund which will be abundant security for the repayment of an advance of funds sufficient to acquire the water supply, construct the entire gravity system and dispense with the expensive pumping plants.

Your committee does not consider any argument necessary to prove the desirability of abandoning Lake Washington and securing Cedar River as a source of supply. It is sufficient to state that the prosperity of the city will force such an abandonment for sanitary reasons sooner or later, and that in Cedar River lies the only hope of the city for a pure, adequate, economical and permanent water supply. While the condemnation powers

of the city are ample and sufficient for all emergencies, it is well to take notice that we have reached a stage of this problem where delays are expensive if not dangerous. During 1889, 1890 and 1891, at an expense of over $35,000 the city made a thorough series of development surveys, plans and estimates for the Cedar River supply system, under the direction of an eminent engineer, Benezette Williams of Chicago, and only financial inability prevented construction at that time. Later investigations and studies have confirmed the wisdom and applicability of the general plan then adopted, and the city is in a position to enter upon this important undertaking without delay or great preliminary expense and with full information of the subject at command.

Your committee therefore recommends the following plan of operation. That an ordinance be passed which shall:

(a) Order the improvement and extension of the city water works by the construction and addition thereto of a supply system from Cedar River and authorize the Board of Public Works to proceed as soon as possible to call for bids and let a contract for such improvement and extensions, stipulating that payment will be made only in warrants upon the "Cedar River Water Supply Fund of Seattle," and that the contractor shall purchase at par all warrants which shall be issued for amounts required for acquirement of lands or rights, whether by purchase or condemnation proceedings, and for all expenses incurred by the city in connection with the work.

(b) Create special fund to be called "Cedar River Water Supply Fund of Seattle" for the redemption of these warrants, and for no other purpose whatever, and provide that, commencing from the date of completion and acceptance of the gravity system, and continuing until all obligations are discharged, the city treasurer shall set aside into said special fund seventy-five (75) per cent of all revenues from the sale of water from the city waterworks (exclusive of water used for municipal purposes).

(c) Authorize the issuance of warrants upon said "Cedar River Water Supply Fund of Seattle," as required in the progress of the work in accordance with the contract, limiting the issue of warrants to a maximum total of twelve hundred and fifty thousand ($1,250,000) dollars.

(Note—This amount is about $100,000 in excess of the estimated cost of the works.)

Provide that these warrants shall bear interest at the rate of six (6) per centum per annum, payable semi-annually on January 1st and July 1st of each year, interest to commence from the date of acceptance of the completed work. Warrants to be subject to call for payment of principal, in the order of their issuance, to the extent of any moneys remaining in the special fund at any semi-annual period after paying interest due on all outstanding warrants.

(d) Bind the city not to sell or dispose of its water works system without providing for meeting these obligations; also not to reduce the

water rates during the continuance of any of these obligations so that the amounts set aside into the special fund shall for any annual period amount to less than seventy-five (75) per cent of the revenue for the year prior to the date of the contract.

(e) Authorize the Board of Public Works to proceed, immediately upon the awarding of the contract, to secure by purchase or agreement all lands and rights necessary for the construction and perpetual control by the City of Seattle of the Cedar River Supply System. Also authorize the condemnation of all lands and rights required, where purchase or agreement cannot be made upon satisfactory terms. Payments to be made from funds provided by the contractor as provided in the contract.

In recommending the adoption of the plan above outlined, your committee have considered the effect upon municipal finances both for the immediate and more distant future. As a basis for calculations and estimates we have secured from the City Comptroller detail statements (which are submitted herewith) showing the receipts and distributed expenses of the City Water Works for the first eight (8) months of 1895. These are minimum figures, less than for the four (4) preceding years, both by reason of decreased consumption and reduced rates, hence any estimates based upon them will be on the safe side. From these statements the following totals have been gathered:

CURRENT RECEIPTS CITY WATER WORKS

	Per Annum
Net cash receipts	$110,600.94
City Departments	21,704.70
Total Receipts	$132,305.64

CURRENT EXPENDITURES

	Per Annum
Lake Washington Pumping Station	$19,338.10
Broadway Pumping Station	7,233.30
Queen Anne Pumping Station	2,067.95
Office	3,785.47
Operating Mains	3,264.21
Domestic Service (net expense)	4,178.25
Meters	1,849.90
Hydrants	248.67
Total expenditures	$41,965.85

During the eighteen months or two years which must elapse before the completion of the Cedar River Supply System, under the operation of the plan proposed, the city would be put to absolutely no expense in connection with it, the contract and the warrant issue meeting all demands. Hence during that period the surplus receipts would be applied as at present in meeting part of our interest on bonded debt, and in making needed extensions prior to the introduction of the gravity supply. Thus while the city would be doing its full share towards the return of prosperity, fur-

nishing a field for capital and employment for labor, it would be under no added burden until the benefit is at hand, and then the increase of income and decrease of expenditures will make the proposition a paying one to the city.

The economy of the proposed gravity system in contrast with the expense of the existing pumping plan is the kernel of the entire proposition. At a liberal estimate the cost of supplying the water now used throughout the city, including also all offices, mains, domestic service, meters and hydrants, expenses as at present, would be $19,826.50 per annum from Cedar River as against $41,965.85 from Lake Washington. With the increase of population and consequent consumption of water, the expense for pumping from Lake Washington will increase almost proportionately, and there will be a necessity for adding expensive machinery from time to time, while with the gravity system provision is made for a four-fold increase of consumption without new construction and with only slightly increasing annual expenditures.

The question may be asked whether if 75 per cent of the cash receipts be set aside into the special fund, the remaining 25 per cent will be sufficient to pay the operating expenses. An analysis of the official figures already quoted answers this question. Even with the present minimum cash receipts of $110,600.94 per annum the entire expenditures for operating and maintaining the water works if supplied from Cedar River. would be about $19,826.50 per annum, which is only about 18 per cent. This would leave 7 per cent, or about $7,700 per annum for extensions of the distribution system within the city, besides the 75 per cent special fund. These figures do not take into account the water now supplied the various city departments to the value of $21,704.70 per annum, which is a credit of the water works although expressly excepted from liability for the 75 per cent special fund.

The most vital phase of this question as considered by the committee was the probability of discharging the new obligations to be incurred under the proposed plan. We recognize the fact that, although these warrants would not constitute an indebtedness of the city, yet the good name and credit of the city would be pledged to their redemption, both principal and interest. In making the statement that these obligations would all be discharged, principal and interest, within less than fifteen years from the completion of the gravity system, your committee is simply crediting Seattle with a growth of 5 per cent per annum; a population of 60,000 now, 76,576 in 1900, 97,732 in 1905 and 124,734 in 1910. If this estimate of growth be extravagant, then the period of redemption would be longer, but your committee is of the opinion that it is most conservative, and that the prospect of much more rapid growth and discharge of all obligations within 10 or 12 years is within the bounds of probable realization. Even with an absolute standstill at the present minimum of current cash

receipts, the 75 per cent special fund would be ample to pay all interest charges and leave a considerable surplus each year for redemption purposes.

In order that there may be no doubt as to the correctness of the assertion that with a 5 per cent annual increase of population, the entire obligation will be discharged in less than fifteen years we submit a tabulated statement covering the fifteen-year period from 1898 to 1912 (inclusive) indicating the estimated population and the gross cash receipts per annum (based on current rates and receipts), the 25 per cent portion retained by the city for operation, maintenance, extensions, etc., the 75 per cent portion set aside in the special fund, the amount paid out of it for interest charges on outstanding warrants, the amount of warrants redeemed, and the balance of warrants still outstanding. We have assumed the maximum expenditure and warrant issue of $1,250,000 to commence with, and that the supply system would be completed and the warrants begin to bear interest from January 1, 1898.

TABULATED STATEMENT

Showing Redemption Process—Seattle Water Works
Original Debt, $1,250,000—Interest at 6 per cent
Increase of Population Estimated at 5 per cent per annum

Year	Population	Gross cash receipts	25% of receipts	75% of receipts	Interest paid	Warrants redeemed	Balance due
1898	69,457	$128,033	$32,008	$ 96,025	$75,000	$ 21,025	$1,228,975
1899	72,930	134,435	33,609	100,826	73,738	27,088	1,201,887
1900	76,576	141,157	35,289	105,868	72,113	33,755	1,168,132
1901	80,405	148,214	37,053	111,161	70,088	41,073	1,127,050
1902	84,425	155,625	38,906	116,719	67,624	49,095	1,077,964
1903	88,646	163,406	40,851	122,555	64,678	57,877	1,020,087
1904	93,078	171,576	42,894	128,682	61,205	67,477	952,610
1905	97,732	180,155	45,039	135,116	57,157	77,959	874,651
1906	102,619	189,163	47,291	141,872	52,479	89,393	785,258
1907	107,750	198,621	49,655	148,966	47,115	101,851	683,407
1908	113,137	208,552	52,138	156,414	41,004	115,410	577,997
1909	118,794	218,980	54,745	164,235	34,680	129,555	448,442
1910	124,734	229,929	57,482	172,447	26,907	145,540	302,902
1911	130,970	241,425	60,356	181,069	18,174	162,895	140,007
1912	137,518	253,496	63,374	190,122	8,400	181,722	* 41,715

* Surplus.

Reference to the column in the preceding table showing the 25 per cent of cash receipts for each year, and comparison with a gradually increasing expense account from $20,000 per annum in 1898 to about $32,000 in 1912, will indicate the safe margin over and above operating expenses which will be available for extensions of the service throughout the city.

It is also worthy of note that the final discharging of the obligations by about 1910 or 1912 will be at about the time of the maturity of our present bonded indebtedness. Increase of assessed valuations will un-

doubtedly make it possible, and relief from excessive taxation make it wise, to issue sinking fund bonds preparatory to redeeming the present bonds. After 1912 a continued application of 75 per cent of the water rates, and a continued growth of the city, would redeem the entire municipal debt within another fifteen-year period. Once out of debt, the water rates could either be reduced to a minimum cost basis, or applied in such manner as to materially reduce general taxation.

The remunerative capacity of an economical municipal water works is remarkable. Even while dependent upon an expensive pumping system, five years' experience has demonstrated the success of the city's investment of 1890. We are now at a point in the history of the city where the ways clearly part. One road leads via continued expensive pumping, and time contracts for purchase of Cedar River water to an eventual and permanent financial servitude to some private corporation for our most vital municipal necessity. If we enter upon this road the largest and surest source of municipal income will be shut off from the public treasury. The other road leads directly to the immediate possession and utilization of the Cedar River supply, with perpetual public ownership and increasing income devoted to public purposes. Between these ways your committee has no hesitancy in choosing. We believe the time and the opportunity has come when the City of Seattle is in a position to say "Hands off—The inhabitants of Seattle, now and to come, have a paramount claim upon the Cedar River water supply, not to be subjected to those of any private individuals or corporations."

Actuated by this spirit, after careful thought and the deliberation due a proposition of such magnitude, your committee respectfully recommend the adoption of the plan outlined in this report and the passage of the ordinance herewith submitted for the purpose of putting it into execution.

H. R. CLISE,
J. EUGENE JORDAN,
Committee Board of Aldermen.
F. H. HURD,
A. KISTLER,
F. N. LITTLE,
Committee House of Delegates.

The plan of financing the Cedar River project having thus been outlined and recommended by the Council Committee, Ordinance No. 3990 was passed and approved on October 29, 1895, proposing an election to authorize the construction of the Cedar River Water Supply System at an estimated cost of $1,250,000 by the issue of warrants bearing 5 per cent interest per annum, and declaring the city not liable for such obligation except upon the Cedar River Water Supply Fund which it was proposed to establish by the election. The election was held

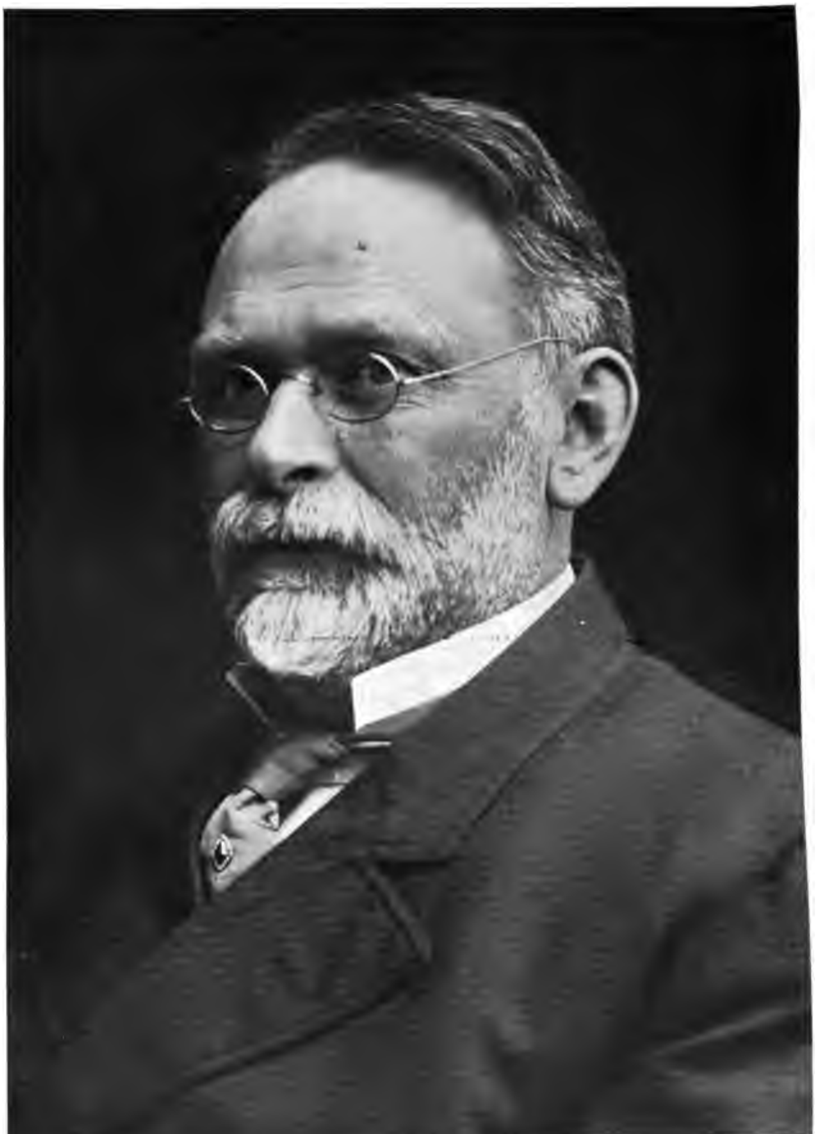
on December 10, 1895, and the proposition to issue bonds for the building of the system carried by a vote of 2,656 for the proposition and 1,665 against it.

As an illustration of the strange way in which public sentiment changes from time to time on matters with reference to which it would seem there should always be a practical unanimity, a comparison between the vote cast for and against the Cedar River project in the year 1889 and the vote cast for and against the same project on December 10, 1895, is not uninteresting.

In June, 1889, a month after the great fire, the vote stood 1,875 for and only 51 against the project. This vote authorized an issue of $1,000,000 in five per cent twenty-year bonds. Six years later, in 1895, the vote stood 2,656 for and 1,665 against the project. It is difficult to understand how 39 per cent of the people could have voted against the plan when it was demonstrably cheaper than the cost of pumping, and supplied water of constant purity, while Lake Washington water was yearly becoming more impure and dangerous for domestic use.

After the warrants had been voted there still remained extremely vexatious causes of delay in the starting of the work. Under the terms of Ordinance No. 3990, which called the election to authorize the issue, the warrants were made payable, principal and interest, from the proceeds of 75 per cent of the gross income of the plant, but no part of them were to be redeemable until water was delivered through the pipe line into the reservoirs in the city, and no interest on the warrants was to accrue until that time. Moreover, during 1896 the market for securities was at a very low ebb, and, aside from the above defects in the warrants, they would have to be sold at a very great sacrifice if disposed of during that year. Owing to the extreme scarcity of money the Council did not make adequate provision for pushing the work of surveys and condemnation without which it was impossible to let a contract. These circumstances, and some others of lesser consequence, were called to the attention of the City Council in a communication from the Board of Works on March 30, 1897, and several recommendations made in connection therewith, which recommendations the Council accepted with slight modifications on April 5, 1897.

During 1896 and 1897 serious complaints had been made that neither the Legal Department nor the Engineering Department were pushing their work as rapidly as they should be. A special committee of one,



R. H. Thomson

consisting of Dr. William Chapman, was appointed by the Council to investigate and report upon the cause of the delay in both departments.

As the work of the Legal Department of necessity depended upon the progress of the work in the Engineering Department, it was easy for the former to explain its relation to the delay.

I have previously noted that the Council, in December, 1895, had appropriated $1,000 in addition to the regular allowance for the engineer's office, for the purpose of making the necessary surveys of the pipe line right-of-way, and securing correct descriptions of all property connected therewith, including the check of the original survey of Benezette Williams and the court costs in the necessary condemnation proceedings.

The sum was absurdly—one might almost say criminally—inadequate for the purpose. Nevertheless, Mr. R. H. Thomson, the City Engineer, by withdrawing his office force from their regular duties in the city and using them on the Cedar River work, was able during the summer of 1896 and 1897 to get the whole immense work ready for letting the contracts for construction. His description of how this was done was detailed in a report made on September 25, 1897, to Hon. William Chapman, who was constituted a special committee of one by the Council to investigate and report upon the cause of delay in getting the preliminary work of surveys, plans and condemnations completed. This work was second to none ever done in this city, in difficulty and importance, and Mr. Thomson's report throws so much light on the conditions then prevailing that it is given in full:

Seattle, Washington, September 25, 1897.

Dr. William Chapman, Special Committee of City Council upon Progress of Works upon Cedar River Water Supply:

Dear Sir:

At your request, I submit herewith a statement of progress made by this department in connection with the Cedar River Water Supply.

It is hardly necessary to refer to the constant efforts of this department during the three years prior to the special election of 1895. It is sufficient to state that, as their result, the city was awakened from five years "sleeping on her rights," the people were brought to an appreciation of the vital importance of the question and a "would-be" water and power monopoly was frustrated in its designs.

The action of the people in December, 1895, suddenly transformed an indefinitely postponed project into a definite public policy. In the execution of that policy the matter of surveys, rights-of-way, plans and specifications demanded first attention. Then for the first time since they

were "pigeon-holed" in 1890, the series of maps, plans, specifications and survey field-books of the "Benezette Williams' plan" were given detail inspection by this department. It was at once discovered that with all their elaboration of detail and the seeming completeness of the plan, there was absolutely no available data to compile a legal description of a foot of right-of-way. There was a line—on paper—and probably a similar line on the surface of the earth, but its relation to the section and subdivisional lines was an unknown quantity, except by scaling on the maps. Moreover, the lapse of seven years' time had made all the surveyed line indistinct and had absolutely obliterated some portions of it. These facts were placed before the City Council within less than a month from the special election of December, 1895, and an appropriation of $1,000 was made for the purpose of re-surveying and accurately defining the "Williams' line." This was done during the spring of 1896. In the meantime studies of the plans and specifications were in progress in the office. These studies and personal examinations made during the progress of the field work, suggested to me the probable economy of certain changes in the plan of "headworks" and aqueduct construction to Swan Lake. Opportunities to secure several necessary ownerships were investigated, favorable terms secured, and upon report to the Honorable Council, provision was made for their purchase.

In the first week of July, 1896, after many weeks' planning, I succeeded in getting Mayor Wood and the Chairman of the Fire and Water Committee, Hon. Ezra Herrman, over the route from the headworks on Cedar River to Swan Lake, and received their hearty concurrence in my expressed conviction that a survey should be made with reference to my suggested change of plan of that portion of the system.

Immediate proceedings towards the condemnation of "headworks" site, right-of-way to and probable submerged area around Swan Lake, were urged by the Mayor at that time, and under his directions and with his personal assistance, approximate descriptions covering those tracts were scaled from the Williams' maps and embodied in the suit which was then instituted by the Corporation Counsel. The theory of these approximate descriptions, as stated to this department, was that exact descriptions could be substituted by amendment when the cases came to trial, and to that end provision was made for pushing the surveys necessary to compile such exact descriptions. I have said "provision was made." As a member of the honorable City Council you will recall the nature of that "provision." The problem of municipal expenses was at a very critical stage just at that time. City bills and salaries of employes were two months in arrears and the dangers of going upon a warrant basis seemed imminent. Furthermore, the nature and excitement of the national political campaign then in progress, absolutely precluded the possibility of any favorable contract before its conclusion. Putting these facts together the honorable City Council "provided" that the necessary surveys should proceed, but without

exceeding the regular monthly appropriations for the department. In this decision I heartily concurred, took the field in person with my regular city office and field force, as assistants, leaving barely enough force in the city to keep the office doors open and attend to pressing routine business. We went upon the ground about the middle of July, 1896, and continued work with the small force above described, until the beginning of stormy weather in November. The result of that work was to confirm my conviction in the proposed change of plan. When we returned to the city we had definitely located a line embodying the proposed change from the "headworks" on Cedar River to Swan Lake. We had also made all the surveys necessary to accurately connect it to the section and subdivisional lines, and were ready to compile exact descriptions of the required rights-of-way, to be substituted for the approximate ones made in July. This compilation was pushed with the greatest diligence upon our return to the city and in December, a new, corrected and proper description of all such rights-ot-way, together with an accurate map delineating the same, were delivered to the Corporation Counsel.

In the study of re-framing the condemnation suits, grave doubts were expressed concerning the complete authority of the city on certain vital points. The meeting of the State Legislature immediately following, furnished the opportunity to strengthen these possible weak points in our legal position. This was accomplished by the co-operation of all departments of the city and the diligent personal efforts of a municipal legislation committee stationed by the City Council at Olympia up to midnight of the closing session to explain and urge the importance of this and other legislation.

With the first opening of seasonable weather in 1897, active work was resumed in the field. The improved financial position of the city made it possible to place two field parties at work. One was placed upon the survey of the Swan Lake basin, where the accurate defining of the limits of the proposed submerged strip, and its relation to the section, lot subdivision and present shore lines was a matter as yet unknown. The second party was set to work upon the revision of the pipe line from Swan Lake to Seattle. Work was pushed upon both these branches to the full ability of the two crews. The second party completed its work on July 10th and was disbanded at once. The party at work around Swan Lake upon the completion of the surveys at the basin, "worked their way" into the city, making the connections of the revised location with the section and subdivision lines. This work proved far more intricate and complex than had been anticipated. Donation claims with their surrounding fractional section subdivisions, and "wild-cat" town lots without number, introduced a multiplicity of tedious tasks. Many cases of disputed and lost corners were encountered and in such cases, problems involving much skill and patience were required to be solved. Permanent monuments were established at all such points. For these reasons the completion of these surveys was de-

layed until August 20th. As fast as the information was secured, office work upon the calculations and compilation of descriptions proceeded. This work is tedious and voluminous and is still in progress. On September 8th I delivered to the Corporation Counsel the descriptions of the tracts required around Swan Lake and the rights-of-way from Swan Lake to Renton, compiled in book form. I also had the descriptions furnished in December, 1896 (covering the "headworks" site and line to Swan Lake), copied and combined with the others in book form.

The descriptions of the rights of way needed between Renton and Seattle are being diligently calculated and compiled, with a force of four or five men at work upon them, and I hope to deliver them to the Corporation Counsel before the end of this month.

While this field work has been in progress, the plans of the various structures required for the system have been studied and many of them perfected in fullest detail. The intake at Cedar River, the settling basin near point of intake, the delivery chamber at Swan Lake, the waste weir at the end of the Swan Lake tunnel—these and other necessary detail plans are complete, ready for examination by intending bidders when the work is advertised, and for intelligent prosecution when the contract is let. The work is also well advanced upon the detail plans of the reservoirs and their gate-houses, and practically completed upon every other detail of construction with the exception of water towers for extreme high service. Even upon these, numerous studies have been made and the burden of the work upon them, I may say, is completed. It would give me great pleasure at any time to exhibit and explain to yourself or to any member or committee of the honorable City Council any and all plans and details.

In conclusion allow me to state that the work of this department upon the Cedar River Water System during the twenty-one months which have intervened between the special election of December, 1895, and the present date, have been constant, painstaking and as extensive as the provisions made by the Honorable City Council permitted.

As the preceding statement shows, the work during that period has been equivalent to a new survey and plans of the entire system. The Benezette Williams' "plan" proved to be a paper theory—and a good one, with some modifications—but it has required practical demonstration upon the ground in order that we may be in a position to put it into practice. The original development surveys cost the city nearly $40,000. The complete reproduction and revision of their results during the past twenty-one months has been accomplished entirely within the ordinary allowance for this department for routine work. From an engineering standpoint I would state most emphatically that the city was never better prepared to commence construction than at the present moment, and that any attempts to have hastened construction without the revision which has been accom-

plished, would, in my judgment, have added cost and seriously affected the efficiency of the system.

Very respectfully,

R. H. THOMSON,
City Engineer.

The cost of the work above outlined by Mr. Thomson is set forth in the following statement issued by Mr. Will H. Parry, City Comptroller.

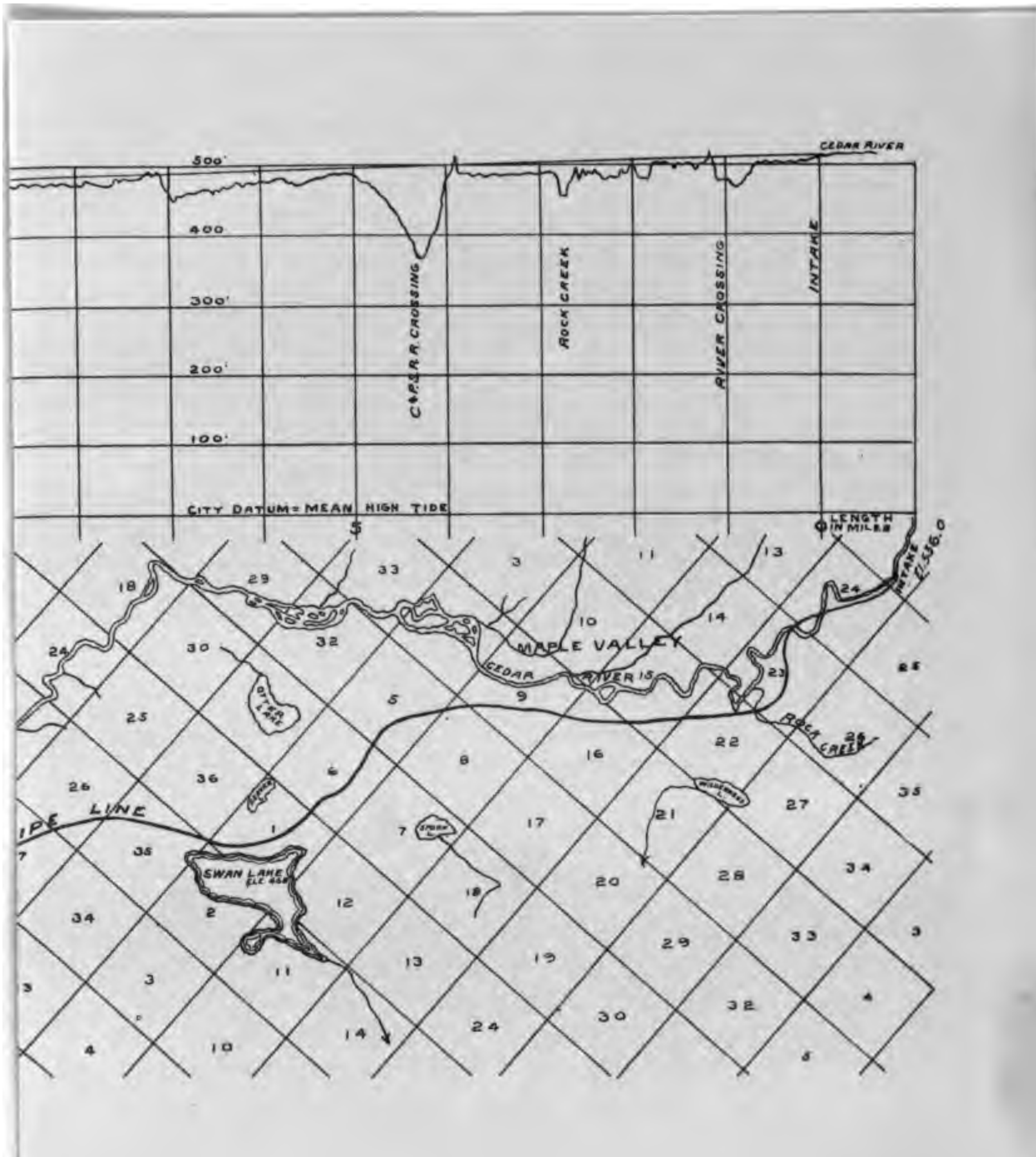
From June 1, 1895, to June 30, 1896,		
For engineering, pay rolls and bills	$2,002.61	
For rights of way, etc.	390.00	
		$2,392.61
From July 1, 1896, to December 31, 1896,		
For engineering, pay rolls and bill	$2,366.31	
For rights of way, etc.	200.00	
		$2,566.31
From January 1, 1897, to July 30, 1897,		
For engineering pay rolls and billls	$4,232.39	
For rights of way, etc.	125.00	
		$4,357.39
Total expenditures to July 31, 1897		$9,316.31

of which $715 was for purchase of lands for right of way purposes and $8,601.31 for engineering and other preliminary expenses.

Considering the magnitude and complexity of the work accomplished the showing of cost is certainly very creditable.

THE CONSTRUCTION OF THE CEDAR RIVER WATER SUPPLY SYSTEM

The final plans and specifications under which Cedar River Water Supply System was built were prepared and the work executed under the general supervision of City Engineer R. H. Thomson. Mr. Henry W. Scott, First Assistant Engineer, and L. B. Youngs, Superintendent of City Water Department, had immediate charge of the work in the field. The contract was let April 19, 1899, in two parts, one part consisting of the dam, headworks and pipe line, which was let to the Pacific Bridge Company, the other part consisting of the Lincoln Park and Volunteer Park reservoirs, with one standpipe on Queen Anne Hill, and pressure pipe connecting same with pumps at Lincoln Park, which was let to Smith, Wakefield and David. The cost of the entire work was equal to the amount of warrants issued, $1,250,000. These warrants are not a general city obligation, but are payable principal and interest from the earnings of the plant.


CEDAR RIVER
500'
400
300'
200'
100'
CITY DATUM = MEAN HIGH TIDE
C.&P.S.R.R. CROSSING
ROCK CREEK
RIVER CROSSING
INTAKE
LENGTH IN MILES
INTAKE EL. 536.0
MAPLE VALLEY
CEDAR RIVER
ROCK CREEK
OTTER LAKE
SWAN LAKE
PIPE LINE

field and David. The cost of the entire work was equal to the amount of warrants issued, $1,250,000. These warrants are not a general city obligation, but are payable principal and interest from the earnings of the plant.

At the present writing, 1914, there are only $510,000 of these warrants outstanding. $100,000, including interest, must be paid on these warrants each year, so that on December 31, 1919, they will be wholly liquidated. The wooden staves in No. 1 line are, however, at this time, quite badly decayed and must be renewed in sections from time to time in the future. The iron bands are still in good condition.

Previous to the construction of Pipe Line No. 1, when the pumping plant was supplying only 11,000,000 gallons per day, there was always a serious shortage of water during the dry months of summer. As most of the consumers then took water on fixed rates (only 13 per cent being metered) the wastage was great on the part of those who had good pressure, with a corresponding shortage for those who lived on high areas and had not enough. Regulations against waste had to be very strict, and every summer from fifteen to thirty additional inspectors had to be employed to prevent water famine in the poorly supplied districts. Pipe Line No. 1 had not been installed more than five years when the same conditions began to manifest themselves during the summer, although its capacity was more than double that of the pumps. It was clear that a new pipe line was imperative, as the water from Lake Washington, owing to the growth of population, had become unfit for domestic use.

Cedar River Water Supply System No. 2

During three or four years previous to 1908 the population of the city was increasing with unprecedented rapidity. By 1907 Pipe Line No. 1 delivered barely enough to supply the summer requirements. This condition had been foreseen, and one year before, on August 8, 1906, Ordinance No. 14116, which set forth a plan for building Pipe Line No. 2, was approved by the Mayor.

Under authority of that ordinance an election was held on September 12, 1906, and bonds were voted in the sum of $2,250,000. These bonds bear 5 per cent interest, and are in reality warrants payable principal and interest from the earnings of the water plant.

The issue of the bonds and the execution of the work was delayed about a year and a half by contradictory statements in the text of the ordinance calling the election to vote the bonds. Section 3 of that ordinance—No. 14116—provides that $175,000 per year shall be paid on the principal and interest of the bonds from the gross revenues of the plant, while Section 5, which prescribes the form of ballot, provides that $175,000 per annum shall be paid from not more than 75 per cent of the gross revenues.

The proposal to issue the bonds carried by a vote of 10,905 for, and 2,044 against. The validity of the vote was affirmed by the Superior Court of King County, but, upon an appeal to the Supreme Court of the State, the decision was not sustained. The decision was rendered on December 10, 1907, so the question of issuing bonds had to come up again at the spring election in 1908.

Under authority of Ordinance No. 17,863, approved January 31, 1908, the question of a bond issue was again submitted on March 3, 1908, and the proposition was carried by a vote of 16,121 for and 2,229 against. Ordinance No. 18216, approved April 13, 1908, provides for the issuance of these bonds, and establishes Cedar River Water System No. 2 Fund. This latter ordinance, however, was repealed by Ordinance No. 18431, approved May 15, 1908, which makes some minor changes in the plan of paying interest and redemption.

This ordinance was in turn superseded by Ordinance No. 18631, approved June 17, 1908, which designates by number the bonds that shall be paid on certain dates.

Before the election, however, and before the decision of the Supreme Court had been rendered, a contract had been let for a part of the work (subdivision No. 2, the excavation of the Beacon Hill Twin Reservoirs) on March 14, 1907, to Hawley and Lane. This firm had to quit work (on account of the decision of the Supreme Court), temporarily, but afterwards took it up when the bonds were again authorized by vote in 1908.

On August 15, 1908, the contract for Subdivision No. 1 of Cedar River Water Supply No. 2 (the pipe line), was let to Grant-Smith & Co., and on June 21, 1909, water from this pipe line was delivered in Volunteer Park Reservoir.

Both pipe lines lie side by side until they reach the corner of Beacon Avenue and Forest Street in the city. They take water from the same settling basin at the same level, 535.8 feet above city datum, and deliver it into the reservoirs at the same level, 420 feet. No. 2 is extended as far north as the Maple Leaf reservoir on the north boundary of the city, while No. 1 goes only as far as Volunteer Park reservoir at Fourteenth Avenue North and East Prospect Street.

In anticipation of the building of Pipe Line No. 2 the question of additional storage reservoirs in the city had to be considered. On February 27, 1906, Ordinance No. 13376 was approved, appropriating $180,000 out of the water fund to build a reservoir in Woodland Park, a tract which had, some years before, been purchased by the city for park purposes. The idea was to avoid paying for a new reservoir site, but the elevation of Woodland Park was found to be too low, and the ordinance was repealed by Ordinance No. 15336, approved February 7, 1907. On this same date the Board of Works was authorized by Ordinance No. 15333 to construct a reservoir on the land secured at East Seventy-third Street and Twelfth Avenue Northeast, and the ordinance appropriated $180,000 from the Water Fund for this purpose. This was the Green Lake Low Service Reservoir.

The sites for the two Green Lake reservoirs were acquired from various persons and at various times during the years 1906 and 1907 for the aggregate sum of $78,843.80.

Previous to this, and in connection with the construction of Pipe Line No. 1 the land upon which Lincoln Park reservoir stands was purchased on November 23, 1897, for $10,800.

The ground upon which the new Beacon Hill twin reservoirs are located was bought from the State of Washington on February 18, 1904, for the sum of $11,771. This tract consists of 235.186 acres in Section 16, Township 24, Range 4. It is now used partly for park purposes.

SALE OF SURPLUS WATER

After Pipe Line No. 1 went into commission in January, 1901, Lake Washington Pumping Station was not needed except for possible emergencies, in case of any failure of the pipe line. The station was therefore leased, under authority of Ordinance No. 7165, approved on August 13, 1901, and Ordinance No. 7642, approved January 20, 1902, to the Seattle and Lake Washington Waterway Company, a corporation organized to fill the tide flats in the south end of the city by dredging, and moving dirt from the adjacent hills. The term of the lease was from November 15, 1901, to November 15, 1904, the rent to be paid for the station being $6,000 per year.

On February 3, 1902, Ordinance No. 7721 was passed authorizing the Board of Public Works to sell any surplus water available from Cedar River supply to the waterway company for one-half cent per 100 cubic feet, on condition that the company should take not less than one million cubic feet of water per day. On the first day of March, 1902, the Board of Works entered into a contract with the waterway company in accordance with the provisions of this ordinance. At that time the City did not need all of the 22,500,000 gallons that Pipe Line No. 1 was capable of delivering, and the sale of the surplus to the waterway company constituted a considerable source of additional revenue, besides aiding in the execution of a great public enterprise.

Under these two contracts the waterway company sluiced approximately 1,000,000 cubic yards of earth from the west side of Beacon Hill into the tide flats. The dirt was taken from a pit about 650 feet from north to south and 1,500 feet from east to west, lying between Ninth and Thirteenth Avenues South and Hanford and Hinds Streets.

After the lease of the Seattle and Lake Washington Waterway Company had expired the Lewis Construction Company leased the Lake

Washington Pumping Station at an annual rental of $3,000 per year. The agreement was entered into by the Board of Works under Ordinance No. 12601, approved July 11, 1905. The lease ran from July 29, 1905, to July 29, 1906. The water was used for sluicing earth into the tide flats. The dirt was taken from a pit which extended north and south from Charles Street between Tenth and Twelfth Avenues South. The lease also granted the use of Beacon Hill Reservoir and the pressure pipe from the pumps to the reservoir.

Ordinance No. 13335, approved February 18, 1906, authorized a renewal of the above lease for two years from and after July 10, 1906. When the lease was executed it ran from July 29, 1906, to July 29, 1908.

In addition to the water furnished by the Lake Washington pumps, Ordinance No. 9962, approved June 17, 1903, granted to William H. Lewis the right to use city water from the mains in the vicinity of the above described pit for the purpose of sluicing therefrom into the tide flats. This ordinance fixed the price of water so furnished at fifteen dollars per million gallons.

When the water from Cedar River Pipe Line No. 2 became available there was a large surplus above the needs of the city, and during the years 1910-11 much of this surplus was used for sluicing purposes. Ordinance No. 23525, approved March 16, 1910, grants to Lewis and Wiley, Inc., a quantity of water not exceeding 20,000,000 gallons per day for sluicing earth on the Dearborn Street regrade, at the rate of fifteen dollars per million gallons.

The contract for the use of this water was executed by the Board of Works on April 7, 1910.

Large quantities of water for sluicing earth have been used from time to time on various street grades since No. 2 was completed. Of the 12,000,000 or more cubic yards removed by sluicing from streets, gravel pits and private property on the Second Avenue, Jackson, Dearborn Street and Denny Hill regrades, not less than 5,000,000 yards were sluiced by city water, and the miscellaneous grading jobs doubtless aggregate 2,000,000 more. This has considerably reduced the cost of local improvements, and, furnished the department some revenue at the same time. About 5,000,000 yards were sluiced by raising water from Elliott Bay and Lake Union through private pumping plants.

PRESENT USE OF SURPLUS WATER DELIVERED THROUGH PIPE LINE

In designing the pipe line both the thickness of staves and the spacing of the bands were arranged for a pipe open all the time at the delivery end. The pressure which the pipe was intended to stand was computed from the hydraulic grade line. The pipe thus being under full flow, and the consumption being less than the delivery, the excess was passed through a waste pipe from Volunteer Park Reservoir into Lake Union, the quantity so disposed of varying with the demand, and this in turn depending largely upon the amount used for sluicing, irrigation, etc. As the greatest demand for electric light comes upon the lighting plant in the winter when the demand for water is at its lowest ebb, it was thought that an auxiliary power plant could be installed at the foot of the waste pipe on Lake Union. Arrangements were made to take water from Volunteer Park reservoir and the auxiliary power plant was built during the year 1912. The original elevation of the overflow was 420 feet. This was raised to 421.75 feet and the top of the intake bell was placed at an elevation of 420.48 feet which gives the Lighting Plant the use of 1.27 feet of water over the entire area of the reservoir, and does not impair the original water pressure in the district served by the reservoir. As the supply pipes from Cedar River are constantly delivering water into the reservoir the auxiliary plant can get enough water to generate 1,500 K. W. of current for about one hour, thereby aiding materially in carrying the electric load over the peak hours in winter.

LOCATION OF SHOPS

Previous to the year 1896 the Water Department shops were located at the corner of Spring Street and Western Avenue. In that year they were moved to Block No. 25 of D. S. Maynard's Plat, which is situated between Fourth and Fifth Avenues South and Lane and Weller Streets. This block was secured by the city on December 7, 1895, from Josiah Collins by trading therefor Lot 2 of Block 16, D. S. Maynard's Plat, situated on the west side of Second Avenue South, near Yesler Way, and assuming a mortgage due Herman Chapin of $4,000.

The shops remained on Block No. 25 until the block was bought on March 16, 1906, by the Oregon and Washington Railway for terminals, for the sum of $359,000. On March 1, 1907, the city bought Block No. 231 of Seattle Tide Lands from J. W. Ball for

$40,000, and on April 5, 1907, the city bought Block No. 230, just north of No. 231 for $56,000, thus giving the city a tract of land two blocks north and south and one block east and west, lying between Ninth and Tenth Avenues South and Lander and Forest Streets. City shops were built on Block No. 230; and No. 231 was kept for storage purposes. The stock was moved from Block No. 25 in June, 1910.

The phenomenal growth of the city from the year 1903 to 1910 made extensive additions to the plant in the city necessary. On February 4, 1910, Ordinance No. 23220 was approved, adopting a system of improvements for which an issue of bonds was authorized in the sum of $1,080,000, by vote of the electors on March 8, 1910. These improvements and additions were as follows:

ISSUE OF EXTENSION BONDS

Standpipe for Magnolia Bluff, including pumping stations......	$ 34,000.00
Supply ma n on North Eighty-third Street, from intermediate service reservoir to Stone Avenue	31,000.00
42 inch supply main from Lake Union to Maple Leaf intermediate service reservoir	180,000.00
Overflow pipe from Maple Leaf reservoir to Green Lake low service reservoir........	16,500.00
Proportion of cost of tunnel under Government canal at Third Avenue West, to be built in connection with sewer system	30,000.00
Connection of Beacon Hill reservoir to Spokane Street line......	14,000.00
Supply main on Boyer Avenue, *et al*	36,000.00
Amount necessary to complete Beacon Hill reservoirs	250,000.00
Amount necessary to complete Green Lake low service reservoir	136,000.00
Amount necessary to complete Maple Leaf intermediate service reservoir	24,500.00
Amount to be paid by city on Spokane Street, *et al.*, Local Improvement District No. 2074	120,000.00
Supply line for Rainier Valley, from Beacon Hill reservoir......	41,000.00
Supply main from East Forty-second Street and Fifth Avenue Northeast to Third Avenue Northwest and Nickerson St.	92,000.00
Lands on Taylor Creek	50,000.00
Casing for standpipe at Beacon Hill	25,000.00
Total amount	$1,080,000.00

The approaching construction of the Lake Washington Waterway made it necessary that tunnels be built under the proposed waterway to connect the sewers, electric wires and water mains in the main portion of the city with those in the north end. On February 4, 1911, the sum of $30,000 was appropriated from the Cedar River Extension Fund of 1910 by Ordinance No. 26304 to aid in the construction of a tunnel on Third Avenue West for the above purposes. This tunnel is intended to carry two 24-inch pipes, one for the intermediate service system and one for the low service system. The Water Fund also paid $40,000 to aid

in building the tunnel on Twelfth Avenue South under Dearborn Street which carries the 42-inch pressure pipe of Cedar River Water Supply No. 1.

Bonds in the sum of $300,000 were authorized by vote of the electors on March 4, 1913, for the purpose of building a tunnel under Lake Union in the vicinity of Seventh Avenue Northeast, but the share of this cost which the water fund must bear has not yet been determined. This tunnel is intended to carry the large 42-inch main connecting the intermediate service reservoirs and also a 20-inch main on the low service system to feed the low district along the shore of Lake Washington; also a 16-inch main to maintain circulation between the north and central parts of the intermediate service distributing system. The tunnel on Third Avenue West and the one under Dearborn Street are now finished. Work on the one near Seventh Avenue Northeast is about to be started.

INTERDEPARTMENT TRANSFERS OF FUNDS

When a special fund is established by ordinance all receipts into that fund are presumed to be applied to that special purpose and no other. The City Council often borrows from one fund to make up a temporary shortage in some other fund, returning the money later to the fund from which it was drawn. The Water Fund has often been drawn upon in this way.

On March 20, 1911, Ordinance No. 26763 was approved, returning to the Water Fund from the Light Fund $45,008.17, being money paid by the Water Fund for the construction of the temporary dam at Cedar Lake and $2,852.92 for the Lighting Department's share of the cost of the right-of-way from Landsburg to the city. There still remains due $53,002, being the amount paid by the Water Fund for the land and water rights of E. H. Ammidown *et al.* between Cedar Lake and the power plant; this tract and the rights connected therewith being for the benefit and use of the Municipal Lighting and Power Plant. It is proposed to have the Lighting Department, as a reasonable return, reimburse the Water Plant for the fixed charges which the Water Department had to pay on this investment.

For the purpose of hauling material and supplies to be used in connection with the construction of the masonry dam for the Light Department, it was thought advisable to build a municipal railway from Cedar Falls Station on the Milwaukee Railway where the municipal power plant is

TIMBER IN WATERSHED

located up to the site of the masonry dam, and thence about two and one-half miles further to the north end of Cedar Lake.

The cruiser's estimate of the amount of merchantable timber on the area which will be submerged when the lake is raised to an elevation of 1,590 feet is about 108,000,000 feet board measure, but the City Engineer who has been in charge of the construction of the railway and of the logging operations on the city land in the watershed until recently, now places this total at about 60,000,000 feet board measure. Of this quantity about 12,500,000 feet have been used by the city in the construction of the dam and other works in connection therewith, and about 17,000,000 have been removed by the Cedar Lake Logging Company, who took the contract for logging the area early in the year 1913. The estimated value of the 30,000,000 feet of lumber thus removed is $50,017.51. According to the City Engineer the value of the timber still remaining would amount to the same figure, making a total of $100,035.02.

While the prime reason for the building of the railway and the removal of the timber was, of course, the construction of the dam, it is claimed by the City Engineer that the main part of the cost of the road should be paid for by the Water Department on account of its use for hauling out the logs from the submerged area. Although the money paid for the acquisition of the lands in the watershed has been drawn from the Water Department resources, the value so far received from the use of the timber by the city and its sale to the Cedar Lake Logging Company has been turned into the Lighting Department Construction Fund, Series H. It is my judgment that an adjustment approximating what is shown in the following statement would be fair to the Water and Light departments, under the circumstances:

CITY ENGINEER (MASONRY DAM)

In Account With City Water Department

	Dr.	Cr.
By Cedar Falls R. R.		$84,415.86
By staves and lumber		4,469.93
To timber taken from storage basin	$50,017.51	
To half cost of C. F. Ry.	42,207.93	
Balance due Water Dept., Jan. 31, 1914		3,339.65
Total	$92,225.44	$92,225.44

Previous to 1913 it was customary for the City Council to draw on the Water Fund at any time for sums needed to pay for the care of water-

mains in local improvement districts where there were mains to be raised or lowered in connection with regrades, paving, etc. These expenses constituted a heavy, and often wholly unexpected draft on the Water Fund, as they were never provided for in the Annual Budget, and frequently ran as high as $80,000 per year. While this practice was going on, the water rates were several times reduced so that the margin which formerly enabled these costs to be met, finally disappeared. It became necessary to provide for these expenses in some other way, so the Board of Public Works in preparing general specifications for city construction work, which were adopted October 10, 1913, provided that the cost of all such work executed by the Water Department should be paid by the local improvement district, instead of by the Water Fund. This relieves the Department from heavy expenses which could not be anticipated, as they were never known when the Annual Budget was made. It is clearly just that when the abutting property owners in any local improvement district want a street improved, and petition for the improvement, that they should stand all costs of that improvement, for the benefits accrue to them alone.

CRIBBING AROUND BRIDGE PIERS ON PIPE LINE

PIER THAT WAS DESTROYED BY THE FLOOD

Break in the Pipe Line

On Sunday, November 19, 1911, one of the bridges supporting the pipe lines at a point one mile west of Landsburg, was carried away by the high water, owing to the change which was previously made in the channel of the river by the Milwaukee Railroad when their line was built through the Cedar River Valley. Piles had to be driven and a temporary bridge erected for the support of the two pipe lines across the channel before the supply could be restored. At 11:50 a. m. on Saturday, November 25, the temporary bridge was finished and the pipe line connected over a space of 304 feet so that the supply was cut off only six days and one hour.

Subsequently a new truss bridge of wood and iron of 200 foot span was built, and the temporary piling removed. This bridge rests upon piers consisting of piling, around which concrete has been deposited. Two frame cribs have been built running up the stream from these piers, one on the west side of the bridge a distance of about 500 feet, and one on the east side, a distance of about 200 feet, rock filled and thoroughly drift bolted together. The cribbing is 7 feet above the highest mark reached by the flood. This cribbing also serves to protect the trestle bents on the east and west sides of the river between the ends of the bridge and the high ground on either side.

In addition to this the Chicago, Milwaukee and Puget Sound Railway deposited several hundred cars of broken rock along their track, extending from the north end of our cribbing on the west bank of the river a distance of 500 feet up stream, all thoroughly protected by rip-rap, so that it seems almost impossible for any accident to occur there in the future, as the scouring of the river which ate away the bank on the west side will be effectually prevented by the cribbing and the rip-rapping. With the concrete piling around the piers the piles will be protected from danger and less liable to be undermined and carried out. I consider the structure practically safe from accident for a long time in the future.

Reductions in Water Rates

We have heretofore given the rates as established by Ordinance No. 253 and Ordinance No. 883, while the plant was owned by the Spring Hill Water Company. A succession of ordinances have been passed since the plant came into possession of the city, all of them lowering the rates below those previously established. In order that these successive reductions may be readily compared we give them together in the order of their enactment:

Ordinance No. 2604, approved February 28, 1893, fixes rates as follows:

Minimum house rate $1.00 per month. Bath and hose 25 cents per month, additional. Each street hydrant, $5.00 per month. Meter rates: Under 25,000 gallons, 18¾ cents per 100 cubic feet; 25,000 to 50,000 gallons, 16½ cents per 100 cubic feet; 50,000 to 100,000 gallons, 13½ cents per 100 cubic feet; over 100,000 gallons per month, 9¾ cents per 100 cubic feet.

Ordinance No. 3094, approved November 22, 1893, fixes rates as follows:

Minimum fixed rate $1.00 per month. Minimum meter rate $3.00 per month. Hydrants $5.00 per month. Minimum rate for irrigation, 50 cents per month. Metered water up to 25,000 gallons per month, 18¾ cents per 100 cubic feet; 25,000 to 100,000 gallons, 11¼ cents per 100 cubic feet. Above 100,000 gallons, 7½ cents per 100 cubic feet.

Ordinance No. 3410, approved June 12, 1894, reduces rates 25 per cent; 15 per cent to take effect on July 1, 1894, and the remaining 10 per cent to take effect on January 1, 1895.

Ordinance No. 3630, approved December 20, 1894, amends Ordinance No. 3410, by reducing all fixed and meter rates (except the $3.00 minimum rate for meters) 20 per cent; 15 per cent to take effect at once and 5 per cent on January 1, 1895.

Ordinance No. 4443, approved March 9, 1897, reduces the minimum meter rate for 300 cubic feet or less per month to $2.00 and establishes meter rates as follows: 800 to 2,000 cubic feet per month, $3.00. The rates then advance by a sliding scale, varying from 10 to 15 cents per 100 cubic feet per month until the quantity consumed reaches 5,000 cubic feet; then by 5 and 10 cent advances per 100 cubic feet per month until the quantity reaches 30,000 cubic feet. Above 30,000 cubic feet per month, common rates are 6 cents per 100 cubic feet and motors, elevators and factories 4 cents per 100 cubic feet.

Ordinance No. 6590, approved February 26, 1901, fixes the minimum house rate at 80 cents, with 20 cents additional for one toilet and 20 cents for one bath, making the charge on a single modern dwelling occupied by a single family on fixed rate $1.20 per month.

Ordinance No. 12966, approved November 1, 1905, abolishes the charge for irrigation on any lot used as a lawn and occupied by a building used as a dwelling, provided the lot does not exceed in area a tract 120 feet by 120 feet, and also provided only one hose is used to irrigate.

The ordinance also establishes a minimum meter rate for 500 cubic feet or less used in one month of $1.00; from 500 cubic feet to 1,000 cubic feet, $1.50; from 1,000 to 1,500 cubic feet, $2.00. No other material change in rates is made.

Ordinance No. 16474, approved July 8, 1907, establishes the price for 500 cubic feet or less through meter in any one month, at 75 cents, 500 to 1,500 cubic feet, 12½ cents per 100 cubic feet. Above 1,500 cubic feet, common rates, 6 cents per 100; above 30,000 cubic feet, 4 cents per 100 feet, for motors, elevators and factories, only. No other material changes are made.

Ordinance No. 21670, vetoed by the Mayor and passed over the veto by the City Council, on August 23, 1909, makes the final reductions in the charges for water up to date. It leaves the fixed rates for a single family, the same as before, viz., 65 cents for house without bath tub and toilet. It abolishes meter rent on ½-inch, ¾-inch and 1-inch meters, and fixes the charges for metered water at 50 cents for 500 cubic feet or less, and all quantities above 500 cubic feet at 6 cents per 100, except water used by motors, elevators, and factories which drop to 4 cents per 100 cubic feet for quantities used in any one month in excess of 30,000 cubic feet.

The above ordinances cover all the important changes in water rates that have been made since the beginning of the plant.

The following tables will show at a glance the remarkable fall in rates from 1887 when the Spring Hill Company owned the plant, up to 1910:

Spring Hill Company's Rates, 1890					Present Municipal Rates, 1910				
Street Hydrants Per Month	House Rates		Meter Rates per 100 Cu Ft.		Street Hydrants	House Rates		Meter Rates per 100 Cu. Ft.	
	Min.	Max.	Min.	Max.		Min.	Max.	Min.	Max.
$7.50	$1.50	$2.50	$0.20	$0.40	No paym'ts	$0.65	$1.05	$0.06	$0.10
Total.............$12.10					Total..............$1.86				

Local Improvement Assessments

On March 5, 1900, Charter Amendment No. V was adopted. This amendment created, for the installation of water mains, what is known as the Local Improvement District System. As nearly all the water mains installed since that date have been constructed under this system, which assesses the whole or a part of the cost of distributing mains against abutting property we give a brief outline of its provisions. Previous to its passage the money for the construction of new mains had been drawn from the earnings of the plant, with the exception of some extensions, principally trunk mains, that were built from a part of the proceeds of the bond issues of 1890 and 1892.

At the time this charter amendment was proposed the need of a more ample water supply had become very urgent, but the receipts of the Water Department did not provide sufficient funds to make the necessary extensions to the mains in the city and pay interest and redemption on the Cedar River Water Supply bonds. It was, therefore, necessary to have a charter amendment which would permit the assessment of most of the cost of distributing mains against abutting property, in the same manner as assessments are made for other street improvements. The system has been in operation since that date and may be outlined as follows:

The City Council may by resolution or upon petition signed by the owners of property aggregating a majority of the lineal frontage and of the area to be assessed for the improvement, determine that a water main shall be laid in any street or streets. A date is fixed by the Council for hearing protests against the improvement outlined in the resolution or petition, and the Board of Public Works is directed to report to the Council on the date set, the estimated cost of the proposed improvement, a statement of the proportionate amount of the cost of same to be borne by the property within the proposed assessment district, and (except in the case of a trunk water main), a diagram showing the property which will be specially benefited by the improvement and the estimated amount to be borne by each lot, tract or parcel of land to be assessed. Such property is assessed as will be served by the water main.

At such hearing interested property owners may appear and present their objections, if any, to the improvement. After considering such objections and the estimate of the Board of Public Works, the Council may then by ordinance proceed to order the work.

After the work is completed an assessment roll is made and collected, usually under the bonding system, with payments extending over a period of ten years.

The City may in accordance with the provisions of Chapter 98, Session Laws of 1911, cause to be laid trunk water mains to serve any particular locality and may levy assessments to pay the whole or any portion of the cost thereof. In such case the district created to bear such assessment shall include as near as may be all the territory in the district to which water may be distributed from such trunk water main through lateral service and distribution mains and services. In distributing such assessments there must first be levied against the property which will derive its service directly from such trunk water main without the necessity of distributing mains, such amounts as would represent the reasonable cost of a local water main and its appurtenances suited to the requirements of such territory, and the remainder of the cost is then distributed over the entire district.

Sanitation in the Watershed

In the spring of 1906, the Chicago, Milwaukee and Puget Sound Railway Company made application to the City Council for a franchise to build and operate a railway line from a point in the watershed near the Municipal Light and Power Plant through the watershed to Landsburg, a distance of eleven miles. As their surveyed route for this whole distance lay wholly within the watershed a question arose about the danger of contaminating the water during construction and operation of the line. The matter was taken up by the State Board of Health, by the King County Medical Society, and by the Chamber of Commerce, all of whom sent committees into the watershed to observe conditions and make reports. The Milwaukee also employed several experts of national reputation.

Finally it was agreed that a committee of experts should be chosen to consist of three men, one to be chosen by the City, one by the Railway Company, and one by the King County Medical Society.

The city chose Dr. A. C. Abbott, Professor of Hygiene in the University of Pennsylvania, and Health Officer of the City of Philadelphia.

The railway company chose William T. Sedgwick, Professor in the Massachusetts Institute of Technology, and Bacteriologist for the Massachusetts State Board of Health.

The King County Medical Society chose Charles Harrington, Professor of Hygiene in Harvard University, and Secretary of the State Board of Health of Massachusetts.

In August this committee submitted its report. This report was printed in Volume 20, Number 4, of the Journal of the New England Waterworks Association, issued in December, 1906, together with the report of John W. Alvord, C. E., specially employed by the Chicago, Milwaukee and Puget Sound Railway, and John W. Freeman, Hydraulic and Sanitary Engineer.

We print these reports as they cover the subject thoroughly and will be valuable for reference, should any future trouble arise from contamination of the water supply.

ON THE PROTECTION OF PUBLIC WATER SUPPLIES FROM POLLUTION DURING THE CONSTRUCTION, MAINTENANCE, AND OPERATION OF RAILROADS, WITH SPECIAL REFERENCE TO THE WATER SUPPLY OF SEATTLE, WASHINGTON; TOGETHER WITH CRITICISMS OF THE PRESENT METHODS OF WATER SUPPLY AND SEWERAGE OF RAILWAY TRAINS

By William T. Sedgwick, Professor in the Massachusetts Institute of Technology, Boston, Massachusetts

Read September 14, 1906

In an address before the New England Railroad Club, in Boston, in November, 1899, the author drew the attention of railway managers to the unsanitary and objectionable practice of allowing the droppings of the closets of passenger cars to be scattered all along the lines, polluting the trucks and roadbed, and to a greater or lesser extent the air, the soil, or water in the vicinity. Since that time other writers have touched on the same subject, but for one reason or another it has as yet received but little attention.

Railways, both steam and electric, in rapidly increasing numbers, have been constructed, maintained, and operated upon the collecting grounds, alongside the principal tributaries, and even over portions of the storage reservoirs, of numerous water supplies, without exciting more than occasional comment or protest. Suddenly and unexpectedly within the last few months the whole subject has been brought to the front by the proposed construction of a great transcontinental railway close alongside a mountain stream used without filtration or storage as the water supply of a large and rapidly growing American city, namely, the city of Seattle, Washington. The Chicago, Milwaukee and St. Paul Railway, in seeking entrance to Seattle, after having selected the Snoqualmie Pass as the proper place for crossing the lofty Cascade Mountains, found the best route from the pass to that city to be one which for eleven miles runs through the valley and very near the shores of Cedar River, the source of the public water supply of Seattle. Much of the land bordering Cedar River is owned by the city of Seattle, having been purchased under the advice of its able and intelligent city engineer, Mr. R. H. Thomson, for the express purpose of protecting the watershed. Hence it became necessary for the railroad to obtain from the city a right-of-way over this land. This was arranged to be done by means of an ordinance requiring the mayor to sign

deeds for such a right of way 100 feet wide and eleven miles long through the watershed and for most of the way very near the river. Such an ordinance was accordingly drawn up, passed by the city council on May 21, and approved by the mayor on June 5 of the present year (1906).

This ordinance marks the beginning of a new epoch in the relation of railways to public water supplies, and hence deserves thorough and careful consideration. As far as I am aware, it is the first example on record of the frank recognition of the dangers involved in the construction, maintenance, and operation of a railway along the shores of a public water supply, together with explicit and extensive provisions for meeting them. I make no apology, therefore, for quoting from it at length. It is entitled:

"ORDINANCE NO. 13836

"An ordinance granting to the Chicago, Milwaukee and St. Paul Railway Company of Washington, its successors and assigns, a right-of-way one hundred (100) feet in width for the location, construction, maintenance and operation of a railroad across and through lands owned by the city of Seattle, in the county of King, state of Washington, and authorizing the execution and delivery of a conveyance of such right of way. Be it ordained by the city of Seattle as follows:

"Section 1. That there be, and hereby is, granted to the Chicago, Milwaukee and St. Paul Railway Company of Washington, its successors and assigns, a right-of-way, in perpetuity, for the location, construction, maintenance, and operation of a railroad upon, across, and through the lands owned by the city of Seattle, in the county of King, state of Washington, one hundred (100) feet in width, being fifty (50) feet of such width on each side of the center line of the railroad of said company as located and staked out upon the ground, which lands are described as follows, to-wit: (Description of lands omitted.)

"Provided, however, that nothing in this ordinance contained shall be construed to grant any right to said railway company, its successors or assigns, to occupy or use the bed of the stream of Cedar River, or any portion thereof, or any of its tributaries, except so far as herein authorized for the purpose of constructing and maintaining bridges across said river or for the purpose of constructing and maintaining embankments for the roadbed of said railroad.

"Sec. 2. The grant of the right-of-way herein contained is upon and subject to the following conditions, to-wit:

"1. Said grantee shall begin the construction of its railroad upon the right-of-way herein granted within one (1) year. . . .

"2. No station shall be established or maintained by said railway company, its successors or assigns, between the city intake and the easterly terminus of the right of way herein granted without the consent of the city of Seattle first having been granted by ordinance.

"3. While the said right-of-way is being cleared and prepared, and during the construction of said railroad thereon, the camps or living quarters of the men engaged in such work, and the accommodations for any animals employed thereon, shall be located and maintained at such distance from said Cedar River, in good sanitary condition, as shall be approved by said city of Seattle.

"4. The grantee, its successors and assigns, shall locate the living quarters of any and all employees engaged in the care and maintenance of the railroad constructed upon the right-of-way herein granted, or in the operation and maintenance of any side or passing tracks, water tanks, telegraph or block signal stations or towers, or other appliances, constructed and maintained upon said right-of-way, at such distance from Cedar River as shall be approved by the city of Seattle, and shall maintain such living quarters in good sanitary condition.

"5. The said city of Seattle may employ an inspector to patrol or inspect the work of construction of the said railroad upon said right-of-way for the purpose of ascertaining whether said work is being prosecuted in accordance with the conditions herein contained, and said grantee agrees to pay the cost of such inspection."

Then follows a location of the bridges to be built, with a provision at the end as follows:

"All bridges constructed upon said right-of-way across any creeks or streams intersecting said right-of-way shall be solid-decked structures, and all bridges, trestles, and approaches shall be constructed and maintained so as to prevent any foreign matter from dropping from engines, cars, or trains passing over the same into Cedar River or into the creek or streams running into said river.

"7. Said grantee, its successors and assigns, shall not, during the construction of said railroad, or thereafter in the maintenance or operation thereof, place, throw or deposit, or permit the placing, throwing, or depositing in said Cedar River, or in any creeks or streams running into said river, or upon any ground adjacent to said river, any offensive or deleterious matter which may cause the pollution of the waters of said streams, and said grantee, its successors and assigns, shall at all times maintain the right-of-way herein granted, and the railroad constructed thereon, in such manner as not to cause any pollution to said stream."

Further on is a section in which it is provided that if the railroad, in order to avoid curves of more than 3 degrees, finds it necessary to go into the river—

"Embankments required for the proper support of said roadbed may be extended into the bed of the stream, provided that such embankments shall be built of such material and in such manner as to avoid pollution of the waters of said river, and so as to prevent the escape or passage of offensive matter from or over said embankments into the said river."

Winter in the Watershed

Finally, there is a section not only authorizing the mayor and comptroller, but directing them, "upon the taking effect of this ordinance, to execute and deliver to said grantee a deed conveying in perpetuity . . . the right-of-way herein granted . . . for the construction, maintenance, and operation of said railroad. . . ."

The ordinance was passed by the city council on May 21, 1906, and approved by the mayor on June 5. It thereupon became incumbent upon the mayor to issue the deeds by which the railroad should acquire the right-of-way, and it was supposed such deeds would issue without delay. Up to this time there had been no open opposition to the plan, the ordinance having been prepared by the legal representatives of the railroad company and the city officials, acting together. I am assured by the railroad officials that it was their intention to protect the water supply in every possible way, and that they believed they had fully and adequately done so by the provisions contained in the ordinance.

Not long after the mayor had signed the ordinance, but before he had signed any of the deeds contemplated under it, an agitation arose in the city, alleging that the water supply, instead of being safeguarded by the ordinance, was in reality seriously endangered by it, inasmuch as the building of the railway must of necessity bring into the valley hundreds of laborers of an uncleanly type, who would inevitably pollute the river, while its maintenance and operation necessarily involved the temporary or permanent presence in the watershed of section hands, signal men, trainmen, wrecking gangs, and others, not to mention the thousands of passengers who would annually travel on the road and use the car closets, spit from the car windows, or otherwise contaminate the watershed.

This agitation rapidly grew to large proportions, being participated in by physicians, labor organizations, women's clubs, the Chamber of Commerce, good government clubs, and other public bodies, and before long culminated in an order issued by court on application of the King County Medical Society, composed of physicians in Seattle and vicinity, restraining the mayor from signing the deeds. I am informed that the legal representatives of the railroad, who supposed that they had amply and even generously provided for the protection of the water supply, were nonplussed at this sudden outbreak of popular feeling, and unable to understand why it had arisen, or why it should have reached such proportions. Of the reality or extent of the objections there was, however, no doubt, and in self-defense against the popular storm the authorities of the railroad secured the services of several experts to investigate the subject and report to them upon the question whether the railroad could or could not be built, maintained, and operated in Cedar Valley, as proposed under the ordinance, without endangering the purity of the public water supply of Seattle. These included Mr. J. W. Alvord, civil engineer, a member of this Association; Professor Pammel, of the Iowa State University; Professor Bissel, of the Mechanical Engineering Department of the same institution; Prof.

E. G. Smith, of Beloit College, and afterward the writer. Mr. Alvord, Professor Pammel, and Professor Bissell in due time made their reports, and a brief summary of Mr. Alvord's report appeared in the Engineering News, page 238, August 30, 1906; the complete report follows as an appendix (A) to this paper. These reports threw much light on the situation but did not appear to the citizens to settle the question, and hence did not calm the popular storm.

The citizens of Seattle had long supposed that in Cedar River they possessed a perfect water supply, for Cedar River is a beautiful stream, running through a virtually uninhabited district, and forming the outlet of Cedar Lake, a large sheet of water lying, remote and almost inaccessible, 1,500 feet above the city in the Cascade Mountains. It is surrounded by mountains rising several thousand feet about it—a lake probably as beautiful as is Lake George. When, therefore, Mr. Alvord showed that there were a number of logging camps on the watershed with very defective sanitary appliances, practically draining directly into the stream or its tributaries; when he further showed that the sawmill camp of Barneston, having about one hundred and twenty people, partly Asiatics, connected with it, was virtually draining into the stream, and that similar nuisances existed elsewhere on the watershed, the people of Seattle were surprised and greatly annoyed. The conclusion of Messrs. Alvord, Pammel, and Bissell, briefly stated, was that the water supply was already far from perfect, that the railroad could be safely built through the valley, and that it would not be as much endangered by the coming of the railroad as it was already endangered by existing nuisances.

Professor Smith arrived on the ground somewhat later than Mr. Alvord, Professor Pammel, and Professor Bissell, and proceeded to make his own investigations. The author arrived later still, but even before he had come the physicians and other objectors to the ordinance had expressed their readiness to accept as final the opinion of any one whom they considered as an unprejudiced expert, or of any group of such experts, regarding the question at issue. After considerable discussion and delay it was agreed on all sides to leave the settlement of the matter to a commission consisting of Dr. A. C. Abbott, Professor of Hygiene in the University of Pennylvania and health officer of the city of Philadelphia, on behalf of the city of Seattle; Dr. Charles Harrington, Professor of Hygiene in Harvard University, and secretary of the State Board of Health of Massachusetts, on behalf of the King County Medical Society; and the writer, on behalf of the railway company. Meantime, Mr. John R. Freeman, the eminent hydraulic and sanitary engineer, who fortunately happened to be passing through Seattle on his way to Alaska, was prevailed upon to visit the watershed with some of the other experts and to make a special report on the subject to the State Board of Health of Washington which, through its energetic and able secretary, Dr. E. C. Heg, had already taken

an active interest in the problem and had instructed its engineer, Prof. W. J. Roberts, of Pullman, Wash., to make an independent investigation.

As a matter of record and for convenience of reference, the report of the commissioners, Mr. Alvord's report, and Mr. Freeman's report are printed as appendixes to this paper, and since these cover completely and in detail all the points at issue I need not here dwell further upon these. There still remain, however, certain other important aspects of the relation of railroads to water supplies which deserve our careful consideration.

THE WATER SUPPLY AND SEWERAGE OF RAILWAY TRAINS

As I have already said, as long ago as 1899 I urged the members of the New England Railroad Club to devise some better methods of disposing of excrements than those now customary on railroad trains. I dwelt also at much length upon the need of improved water supply arrangements—a subject which still deserves the closest attention. Through cars are often run great distances, passing through various cities and towns en route, and receiving from time to time fresh supplies of water. It may, therefore, easily happen that if any one of these supplies is impure, the water tanks shall become contaminated, and persons traveling in the car, or even joining it at stations which have excellent water supplies, may be exposed to the danger of contracting disease. I have myself had offered to me in a dining car in New England a clayey water which had obviously been taken into the water tanks on the previous day when the water supply of the car had been replenished in Washington, D. C. To a very much less extent travelers may be exposed to similar dangers from contaminated ice.

The importance of the distribution of contaminated water from large centers such as Chicago, Cleveland, Pittsburg, and Washington, having now or having recently had polluted water supplies, is very great, and well deserves the keenest attention of epidemiologists, especially of those who have been puzzled to explain the excess of typhoid fever in the United States over that in other civilized countries, such as England and Germany. At the same time the railroad companies can hardly be blamed for filling their water tanks from any accessible water supplies which are locally deemed good enough for the use of the public.

There still remains, moreover, a feature of the method used for water supply within the cars themselves which calls for serious criticism, and that is the use of the common drinking cup which here, as always, is a well-known sanitary abomination. A dozen or more years ago it was the almost universal custom on American railways for one of the brakemen to carry through the cars a tin can to which were attached a couple of removable cups or glasses. These were used in turn by thirsty passengers who remained in their seats, the glasses being filled for them by the brakeman as he paused for the purpose. This practice is now largely done away with.

and in its place a single cup or glass is kept under a fixed water tank, from which a jet of water can readily be drawn into the cup or tumbler, which is thus intended to serve the wants of the population of an entire car. Any one who thinks that this plan of meeting the water supply needs of a large number of people of all sorts is either attractive or wholesome, has only to sit near the water tank of a crowded excursion train on some hot summer day, especially if the car is filled with mothers and young children, in order to be quickly convinced that a reform is here urgently demanded. Few things are more trying to a sanitarian than to observe a series of thirsty passengers of all degrees of cleanness and uncleanness applying their lips in succession to one and the same tumbler which is seldom, if ever, even rinsed between times. Wholly apart from the question of the quality of the water furnished, the opportunity here provided for the exchange of disease germs must be apparent to any one, and I need not further enlarge upon this custom, which is both familiar and disgusting.

A remedy might easily be found by having the the faucet of the water tank bent upward and provided with a special orifice so that a small jet should rise for an inch or so above its tip, thereby furnishing a "sanitary fountain" similar to those which, in increasing numbers, are being provided in parks, playgrounds, gymnasia, schools and other places where many persons must, of necessity, drink from a common supply. Travelers should also be encouraged to bring with them on railways their own private drinking cups.

Criticisms have frequently been made of the filling of the water tanks and the handling of broken pieces of ice for the tanks by employees whose hands are far from clean, and it must be admitted that the whole matter of the water supply and ice supply of passenger trains frequently leaves much to be desired in the way of sanitary improvement.

As for the sewerage of trains, within a few years, and from motives of mere decency, the custom has become general of locking the closets for the purpose of excluding passengers from them on trains approaching or standing at important stations, a practice which, as will be explained beyond, while certainly contributing to the cleanness of the station platforms, is decidedly objectionable on hygienic grounds. Only in very rare cases, however, so far as I am aware, are the closets of the numerous passenger trains on a great trunk line kept locked for several miles while approaching and after leaving a station, not for decency's sake but in order to protect a public water supply.

Near the city of New Haven, Conn., many travelers have noticed that the closets on the Pullman and other cars going east are kept locked after leaving the city until Branford, nine miles away, has been passed. Going west, the closets are locked as the trains approach Branford and are not unlocked until after leaving the New Haven station. I am informed that the reason for this practice is that some two or three years ago inspectors employed by the New Haven Water Company, while patrolling

the Lake Saltonstall watershed near Branford, observed and reported upon the presence of fecal matter on the rails or roadbed, very near the intake of the Lake Saltonstall supply of the water company, which company thereupon complained to the railway officials, who issued an order requiring all closets to be kept locked on trains traveling between Branford and New Haven. I am also informed that a similar rule requires the locking of all closets on trains on the Northampton Division of the same road between New Haven and Cheshire, a distance of fifteen and one-half miles, for the better protection of another supply of the New Haven Water Company, the Lake Whitney supply.

I have been unable, however, to find that any similar precautions are taken in regard to freight trainmen. On the contrary, inquiries have shown that on our eastern railroads the freight brakemen and trainmen have to get along the best way they can in answering the calls of nature. I am told that in the West there is generally a closet in the caboose for the use of these men, but that near Boston the crews of freight trains either make use of empty box cars, which they defile at their convenience or necessity, or of the coal pile in the tender; or that, when taken hurriedly, they even use as a seat the couplings or bars connecting the cars—obviously an uncomfortable and dangerous practice, especially when the train is moving rapidly. All of these facts further illustrate the crudity and primitive character of the sanitary arrangements of our American railway trains, for, obviously, no occasional locking of closets on passenger trains will ever be more than a partial and very superficial remedy of the present crying evils.

The New Haven case is the only one of which I have heard in which definite fecal pollution of the rails was observed near a water supply, or in which any similar observation led to an immediate attempt at reform. I have recently learned, however, from Mr. R. W. Pratt, chief engineer of the State Board of Health of Ohio, of a case not exactly identical with the New Haven case, but so nearly in the same category that I have asked him to give me a statement of it, which he has kindly done, and which he permits me to quote here:

"The village of Plymouth, Ohio, has, until recently, used as a partial source of water supply a small tributary of the Huron River. Water was taken at a point a short distance southeast of the village, immediately north of, and very near, the Northern Ohio Railroad bridge, which spans this tributary stream or creek. Two hundred feet west of the creek, and twenty or thirty feet above it, adjacent to the railroad, is a water tank used for railroad purposes. A small gully runs from the tank to the stream, which it enters just above the intake.

"In June, 1905, during an inspection of the public water supply by a representative of the Ohio State Board of Health, an eastbound train, composed of freight cars, cattle cars, and one passenger coach, stopped at the tank to take water. After filling the locomotive tender, the train slowly passed on to such a point that the forward cattle car was brought directly

opposite the tank. The day being hot, the animals were badly in need of water. In order to water them, a brakeman swung the spout of the water tank directly into the car, turned on the water and signaled for the locomotive to move slowly forward. By this procedure the cattle and hogs in the several cars were given a generous shower bath, while much of the accumulated filth in the bottom of the cars was flushed out into the gully by the side of the track, through which it flowed rapidly down to the creek, quickly entering the latter at a point not more than fifty feet above the intake of the Plymouth water supply.

"Inquiry showed that this was a common practice on the part of the railroad men during warm weather. It should be added, however, that the railroad officials, when the matter was brought to their attention, agreed to see that the practice was discontinued; and that the village has recently taken steps to procure a sufficient water supply from other sources, so that the use of the creek water will not be necessary in the future."

This case seems to me to be a very important contribution to the literature on this subject, which at best is but scanty, for I may say parenthetically that I have examined English and German authorities and have found nothing of any consequence in them on this subject. One would, perhaps, not expect to find much in such works, because foreigners, as a rule, use closets at stations, leaving the trains when necessary for that purpose. It is, generally speaking, only on the fastest trains that closets are provided, and from a German work on railway hygiene, published in 1904, it appears that the discharge pipes from the closets of German express trains discharge their droppings upon the roadbed precisely as ours do.

Finally, quite apart from the matter of sewage disposal, let us consider briefly the hygienic aspect of locked closets on railways. In the first place, although it is true that our commission recommended the locking of the closets while trains were going through the Seattle watershed, we did not depend upon such locking as an entire safeguard, and I do not believe that locking ever will be a complete safeguard. There are times when people are ill, when they simply *must* get access to the closets. There are times when persons so imperatively require to get into the closet that they will tip the porter heavily, or do almost anything, in order to obtain admittance. And they ought to obtain entrance. It is a hardship, and worse, not to allow access to the closets, the locking of which must be pronounced, once and for all, an imperfect, crude, and, not infrequently, an absolutely barbarous device. The practice is rude and unhygienic, even in its least objectionable form of locking the closets only while the train halts at stations. For any longer period, as for example, while trains are covering the distance from New Haven to Cheshire or New Haven to Branford, or *vice versa*, it is much worse.

Moreover, the practice is not only barbarous and unhygienic, it is often ineffective. How is anybody going to be driven out of a closet at the right time if he is already in it before the train arrives at New Haven going

east, or at Branford going west? I have myself, while observing the actual working of this regulation, been informed by a porter as we passed by the New Haven intake near Branford that he could not lock a closet as "there is somebody in it." The regulation is clearly ineffective and unworthy of modern industrial organization. It must be done away with, and that at the earliest possible moment.

As to the dropping of the excreta through the discharge pipes upon the roadbed, this, also, is a crude, unsatisfactory and unsanitary way of disposing of excreta on trains. At best it necessarily soils the track and the trucks, for the section hands and others to walk or to work upon; it sometimes endangers public supplies of water; it always pollutes the air, and under some circumstances, by being carried by section laborers or others on their hands to their homes, endangers persons not immediately in contact with the roadbed or rolling stock.

But, it will be asked, what can be done about the matter. The answer is that the time has come when we must insist that if a railroad company finds it practicable to carry large iron tanks under passenger cars for gas or for refrigerator purposes, it can and must also carry there an iron tank for sewage. If for any reason this is impracticable, earth closets with pails frequently changed may be used. Railroads must somehow cease distributing fecal and urinary matters all along their lines. The closets ought not to be shut up, either at stations or anywhere else, so that the all-important personal hygienic requirements are defeated. The sewage tanks or pails could be emptied at selected places, either at the end of the run or, on long runs, at principal stations, precisely as water and gas are now taken into special tanks at principal stations. Of course there would have to be disinfection from time to time, and some trouble would have to be taken to see that the sewage tanks were kept clean and free from smells, but this could be done and ought to be done. At any rate, something different from the present crude, disgusting, and dangerous practice must be devised. And, where railroads run over or very near water supplies, as they often do and often must, if common decency and the comfort of the men are not enough to secure it, some provision must also be required for the convenience of freight trainmen. Upon wrecking trains and repair trains it would be easy enough to carry a portable closet, or a fixed privy with earth closet underneath, so that all excrements should later be carried from the watershed and deposited at a distance.

I am aware, of course, that tanks underneath the cars would, in winter, be exposed to freezing, and that special pains would have to be taken to prevent this. It will not be as easy, certainly, to get rid of the excreta in a decent and scientific way, as it is simply to let them drop down through a hole in the floor, but we have got through dropping excreta in that way in our houses and hotels, and we must stop doing it in our traveling houses or hotels, that is, in our passenger cars. Waterworks authorities, especially, must insist that whenever a railroad passes over a watershed it shall be

subject to regulations regarding the discharge of excreta not less stringent than those which would be applied to an hotel or other place of public resort situated on the same watershed.

(As this paper is passing through the press, my attention is drawn to a newspaper statement touching another aspect of the sanitation of railway trains, namely, their garbage disposal:

"It was a surprise to me last week to see, just below the picturesque stone bridge which crosses the main street of ——, a trap for maladies of some sort, if not for typhoid. On the narrow roadbed, and almost covering the railway tracks, were strewn refuse of all kinds, soiled papers, fragments of cooking—in short, all the debris of human life that makes excellent food for pigs, with streams of dirty water forming pools that might sink into the soil eventually, but at present were stagnant. The spectacle gave me a jolt. It was so foreign to the general impression one receives of prosperous —— above ground, and it was wondered how such a garbage hole could ever be overlooked by the powers that be. No doubt this blot on the railroad banks has escaped the management's eagle eye.

Doubtless some of the employees upon dining cars and other departments of railway service look upon railways very much as some Americans look upon their streets, namely, as being practically waste baskets, garbage pails, and sewers. In all these matters our people are generally uneducated and careless. In the city of Boston the police commissioner has lately set a commendable example by ordering the arrest of all persons misusing the public ways in the manner just described, and a similar solicitude for the sanitary care of our railways on the part of railroad officials would doubtless effect a corresponding reform.)

APPENDIX A

REPORT TO THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY COMPANY OF WASHINGTON, UPON THE SANITARY SITUATION CREATED BY THE PROPOSED CONSTRUCTION, MAINTENANCE AND OPERATION OF ITS LINE THROUGH A PORTION OF THE COLLECTING GROUNDS OF THE PUBLIC WATER SUPPLY OF THE CITY OF SEATTLE.

By John W. Alvord, Consulting Engineer.

At your request I have examined a large portion of the Cedar River watershed, the projected line of your railway, and the sanitary situation occasioned by its construction and operation. For this purpose, in company with Professor Bissell and Professor Pammel, of Ames, Ia., a week was spent in an examination of the territory in question.

During this trip we were accompanied by the division engineer of your company, Mr. Wilson, who pointed out the proposed location of the track from the company's plans and profiles. On Monday, the 16th of July, we entered the watershed by way of North Bend, examined the sanitary situation at the city's power house, and from thence drove up to the outlet of Cedar Lake, examining its shores in the vicinity of the outlet and at the outlet works in general. We then returned to the power house and commenced a detailed examination of the located line of your railroad from the power house to the city intake, measuring at frequent intervals the distances of the center line of the right of way from the water's edge, noting the soil conditions and other data. That portion of the line between the power house and Barneston is quite accessible for examination and was easily covered in the afternoon of the 16th.

DIFFICULT TO TRAVERSE

We spent the night of the 16th at Barneston, and the next morning continued down the line of the right-of-way from Barneston to the city's intake. This portion of the line is inaccessible and difficult, the surveyors' line passing through heavy timber and dense underbrush and over many fallen logs and other impediments. The night of the 17th we spent at Ravensdale, and on the morning of the 18th took horses for Kangley, noting soil conditions, habitations and other data at that point, and the terminus of an interesting creek which lost itself in the porous soil just west of that station. We spent the night of the 18th at Barneston.

On the 19th we proceeded afoot by forest trail to the line of the Columbia & Puget Sound Railway, near Weyerhaeuser's logging camp No. 4. From there we proceeded to the Denny-Clay Company's works, the

logging camps in the immediate vicinity, and the settlement at Sherwood. We continued from there to Walsh Lake and returned to Barneston that night. On the 20th we covered the territory drained by Taylor Creek, visiting Miller's logging camps Nos. 3, 5 and 6, also the intake and dam of the Barneston water supply on Taylor Creek and the shingle mill about a mile south of Barneston. On the 21st we noted the sanitary conditions around Barneston, and took the train for Seattle.

At the time the Seattle water works were first constructed I also visited this watershed in the interests of those who were expecting to take the bonds of the projects, becoming fairly familiar with the topographic conditions of that section.

THE WATERSHED

The watershed of the Cedar River above the intake appears to be one of the most extensive areas of porous soil utilized for natural filtration of a public water supply which it has ever been my fortune to observe. The glacial drift of which it is composed consists of coarse and fine gravels intermingled to a depth of some hundreds of feet. We looked in vain for traces of clays or finer soils. The surface mold is thin for the most part, and the level of the soil water on the benches and plateaus back from the river is evidently at a great distance below the surface, as indicated by the location of springs and the depth of the eroded streams. There is little or no surface run-off of the rainfall. Numerous potholes exist, depressions without visible outlet, and there was scarcely observed a dry run of any kind, or rivulet, save those of running streams, few in number, which were marked upon our map.

The unusual porosity of the soil may be best illustrated by the statement that in passing over the located line of the railway, eleven miles along Cedar River, no run or rivulet or surface indication of wash of any kind was observed leading into the stream, which would indicate that the rainfall passed over the surface of the ground. We also observed that in passing over the Northern Pacific Railway, which crosses the watershed from north to south, no pains were taken by that company to ditch its tracks, to provide small culverts, or even, in the case of very considerable depressions, to arrange for the passage of water from one side of its embankment to the other. The soil, therefore, of this valley is a porous one, receiving the copious rainfall of this region and largely absorbing it, and by slow percolation filtering it to an unusual degree, thus creating the clear streams and exceptionally pure water.

POPULATION OF THE WATERSHED

As nearly as our inquiries could determine, the population of this watershed is about 1,500 people, mostly employees of the various logging companies living in camps and concentrated at certain points along the small streams which are tributary to the Cedar River. This class of popu-

lation is perhaps not the most desirable from a sanitary point of view, and their environment and situation, as we saw it, is not attractive. The camps are serving generous quantities of food to the men much of which is wasted, and in order to dispose of this refuse in any considerable camp a dozen or more hogs are kept and fattened from the garbage of the camp. The hog pens invariably extend into the running stream, so that the hogs may water there at will.

We observed contamination of this character at Miller's Camp No. 5, situated on the north fork of Taylor Creek. This camp is working at the present time about 60 men. The liquid refuse of the kitchen is delivered immediately upon the bank of the creek, and the hog-pen is situated so that the hogs have direct access and were observed fouling the creek. The creek has a flow estimated at from 4½ to 5½ cubic feet a second, and is distance from the intake approximately 15⅜ miles, measured along the flowing streams. Such flow measurements as we made indicated that the rapidity of the stream was in no case less than a mile an hour, and often exceeded two miles an hour, the fall being very great.

LOGGERS POLLUTE THE WATER

At Miller's Camp No. 3, working now about 15 or 18 men, there were two privies and a garbage pile in the immediate vicinity of the stream, so situated as to pollute the same. An old abandoned camp in the northern part of section 30, township 22, range 8 east, showed traces of pollutions in the vicinity of Taylor Creek in the shape of carcass remains, garbage piles and privies. This camp was about 400 feet from the stream, however, the ground sloping down to the creek.

Miller's Camp No. 6, working 65 men, is situated upon a side hill a considerable distance from running water, the water supply being pumped up from a spring some 2,000 feet lower down upon the slope. Pollutions at this camp, which were similar in all respects to the other camps observed, would, therefore, not be a sanitary menace. At Kangley there are habitations and a sawmill, and the pollutions similar in all respects to the other camps observed were drained by a flowing brook running past the station. This stream pursues its course to a point about one-half mile below the station, and although flowing an amount of water estimated at 8 or 10 cubic feet per second, disappears entirely into the porous soil and sink holes in that vicinity.

At Weyerhaeuser's Camp No. 4, situated on a stream flowing about five cubic feet per second and running into Rock Creek, there is a logging camp, with some six bunk houses located immediately over the brook, and garbage piles and privies immediately adjacent to the same. Below the camp a hog pen, containing 15 hogs, was so situated that the stream was enclosed, creating conditions which were far from desirable. The distance from this source of pollution to the intake, measured along the line of the flowing stream, was 5⅞ miles.

At the Denny-Clay Company's works we were told that there were about 100 men at work and probably 500 people in the vicinity. There are perhaps 25 houses of all kinds, besides the company's plant, including a considerable camp, sewered into a small rivulet flowing, at the time of our visit, perhaps 1½ cubic feet per second, and draining into Webster Creek.

Proceeding down to Walsh Lake we found upon its banks a log-loading outfit immediately adjacent to the mouth of Webster Creek. We observed at this point that the loggers themselves were not in the habit of drinking the water from this brook, but obtained their drinking water from a spring some twenty-five minutes' walk up the railroad. Walsh Lake has fairly good shores, although considerable decaying timber is found about the lake, as is the case with all other lakes and streams in this country. Three habitations were observed on the opposite banks of the lake which appeared to be accupied. Each habitation was provided with barns, etc., which apparently drained into the lake. Persons were observed bathing on the opposite shore of the lake. A little farther south from the outlet of Webster Creek is another log-loading outfit, working about 50 men. The out let of Walsh Lake, meeting the stream which flows by Weyerhaeuser's Camp No. 4, forms Rock Creek, and at the junction of these two streams is situated Weyerhaeuser's Camp No. 2, containing, we are told, 85 men. The camp is situated 4½ miles above the city's intake, but owing to the lateness of the hour we were unable to visit this camp and obtain any data as to its sanitary condition.

POLLUTION AT BARNESTON

The sawmill and camp at Barneston are situated upon an upper bench or bank, perhaps 600 to 700 feet distant from the edge of the river. The drainage of the benches at this point, if they may be said to drain at all upon the surface, is, generally speaking, away from the river, their elevation along the outer edge being higher than at a little distance back. While there is considerable pollution at Barneston and a large camp, it is probable that for the larger part it sinks into the soil and is well filtered before reaching the river. A considerable number of hogs and cattle, however, have free access to the water of Cedar River, and roam over the camp at will. Barneston is situated about 9¾ miles above the intake, measured along the line of the flowing stream.

Between Barneston and the power house the City of Seattle has constructed its pole line along the north bank of the river and somewhat closely following the same. For the purpose of access to this pole line, and probably originally for construction purposes, there has been built a road which follows the bank of the river, in places coming within 25 feet of the water's edge, giving full and free access to the river for the whole of its distance. Fishermen were observed trout fishing; remains of dinners were observed at the water's edge. Not far below the power house a considerable number of cattle were pasturing, which have ready access to the water of the river.

A number of log jams in the river were noticed, and a great deal of decaying wood lines the stream banks, which, while common to this part of the country, is not usually considered a desirable feature of a watershed for public water supply. The sanitary conditions at the power house and the habitations there could not be criticised.

CEDAR LAKE

The outlet of Cedar Lake was viewed. The lake appears, in many respects, to be an ideal one for purposes of water supply, the banks being for the most part steep. Near the outlet an extensive swamp borders the lake, filled with decaying wood and teeming with aquatic life. The premises of the keeper of the inlet works appeared to be properly protected, although six head of sheep were observed grazing about the outlet and having free access to the river. Fishermen were observed in a boat upon the lake, and the excrement of cattle upon the banks of the outlet. At one point, about 20 feet from the water's edge, human excrement was observed and noted. It is apparent that, while the conditions at this point are not serious, reliance is had fully upon the wildness and inaccessibility of the spot rather than upon any sanitary control.

The river between Barneston and the intake runs through an exceedingly wild and inaccessible region, and is very difficult of access. At only two points in this reach does the railroad line approach closely to the river, and at places it is from 900 to 1,400 feet away. No serious pollutions of any kind were observed upon this section; just above the dam of the intake there appeared to be an undesirable swamp on one side of the stream.

SUMMARY OF OBSERVATIONS

Speaking generally, our impression was that the City of Seattle has an exceptionally good watershed, consisting of forest covered mountain slopes and highly permeable soil, which forms, in the lower part at least, a great natural filter; mountain brooks, spring-fed and of great natural purity, freedom from permanent population, and a copious rainfall. These advantageous natural conditions, however, have not been protected, possibly by want of adequate legal powers, but certainly by lack of suitable sanitary supervision. Many portions of the district being virtually inaccessible, much serious pollution is permitted which is probably for the most part unknown to the authorities.

There are about 25 miles of railroad now existing in the watershed. A considerable portion of this mileage is logging roads owned by private companies. Nearly all of these roads were traversed by us during our examination, and in no case did we see anything which seemed to us dangerous or menacing from their presence. The real menace which we observed lay in the conduct and character of the camps which were located upon flowing streams.

PROPOSED RAILROAD LOCATION

The Chicago, Milwaukee & St. Paul Railway is proposing to enter the Cedar River watershed at or near the present power house, and traverse the valley to the intake along a line for the most part south of the river.

Ordinarily the presence of a railroad track and trains within a watershed is not looked upon by sanitary authorities as a menace when properly regulated. It is through the population and industries created by railroads that sanitary difficulties occur. Pains have been taken to investigate a considerable number of watersheds in this country which draw their waters from surface supplies, unfiltered either by artificial or natural means, and it is found that an exceedingly small proportion of cities are able to make the claim that no railroads exist upon their watersheds. Indeed, the question, so far as can be ascertained, has never before been raised as to the menace of the actual track and trains.

Following are some of the more important cities in this country which derive their supplies from surface sources, with the approximate mileage and number of stations upon their watersheds.

R. 11 E.
Snoqualmie
Chair Peak
Snoqualmie Pass
Kendall Peak
Gold Creek
Coal Cr.
Rocky Run
Granite Mt
Silver Peak
Keechelus Lake
McClellans Butte
Mt. Whitcher
Watershed
Rooster Comb Mt
Borup
Weston
Lester
Hot Springs
Troutdale
Green
Sunday
Friday
Lester Creek
R 9 E
R 10 E

City	Population in 1900	Source	Approximate Mileage of Railroads and Number of Stations
New York, N. Y.	3,350,000	Croton River	45 miles railroad, 18 stations.
Boston, Mass.	560,000	Nashua River, Sudbury and Cochituate	34 miles.
Baltimore, Md.	508,000	Gunpowder River	38 miles, parallel, 41 stations on map
San Francisco, Cal.	342,000	Lake Merced, mountain streams	None.
Providence, R. I.	175,000	Pawtuxet River	10 miles, 10 stations.
Kansas City, Mo.	163,700	Missouri River	Over 300 miles in immediate vicinity.
St. Paul, Minn.	163,000	Small lakes	No railroad.
Rochester, N. Y.	162,000	Hemlock Lake	No railroad. Summer resort around lake.
Denver, Colo.	133,850	South Platte	75 miles, 14 stations
Worcester, Mass.	118,400	Lynde Brook	No railroad.
New Haven, Conn.	108,000	Mill River	35 miles, 10 stations.
Fall River, Mass.	104,800	Watuppa Lake	5 miles, 3 stations.
Omaha, Neb.	140,000	Missouri River	210 miles below Sioux City, 12 stations.
Scranton, Pa.	102,000	Roaring Brook, Oak River	10 miles.
Cambridge, Mass.	92,000	Stony Brook	5 miles.
Grand Rapids, Mich.	87,500	Grand River	260 miles, 70 stations.
Richmond, Va.	85,000	James River	150 miles parallel, 92 stations.
Hartford, Conn.	80,000	(Brooks)	15 miles, 4 stations.
Trenton, N. J.	75,000	Delaware River	100 miles parallel.
Waterbury, Conn.	45,800	(Ponds)	No railroad.
Mobile, Ala.	38,400	Clear Creek	No railroad.

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A very large majority of cities, therefore, have railways not only upon the watershed, but paralleling the streams from which their waters are taken, nor do the majority of such cities have excessive death rate from zymotic disease, and, so far as I am aware, no criticism has ever been seriously raised that the presence, at least of the track and trains, in such cases constitutes a menace in any way. But there are sometimes not only practical reasons why precautions should be taken to insure the purity of water supplies, there are also esthetic reasons for guarding against contamination, and particularly in a case like the Cedar River, where preliminary arrangements are possible and where proximity to the flowing stream is close, it would seem wise that some precautions should be observed which would prevent the drainage from the track from directly entering the stream, or which would prevent those passing along the tracks from access to the stream in any way.

THE OPERATION PROBLEM

The fact that a railroad will be constructed the entire length of the river from the power house to the intake, has advantages as well as disadvantages. It provides means of approach to the river at points where it is now inaccessible, but it also provides at the same time means for controlling the watershed and observing its condition not only by the agents of the city but by the observation of the general public as well; this means the public sentiment will by such means be created, which will result in regulations, adequate police powers and proper control. While, therefore, to some degree a railroad so located must of necessity increase access to the river valley, its presence is an efficient check on some forms of pollution which are now in progress and which have been undiscovered.

The precautions which would suggest themselves as desirable would be, first of all, at points where the track is in close proximity to the river, to so drain the roadbed from the cuts into the soil back of the fills that, if there is any possibility of surface wash—a possibility of which I have seen no evidence so far—it shall be carried back upon permeable soil to diked-in sink holes, such as naturally abound all over this area, so that such drainage shall not directly reach the river. The drainage from the outer edge of the track may be intercepted by slightly widening the fills and forming a gutter the waters from which can be led back to the inside of the track in the same way.

FENCE ALONG THE RIVER

Secondly, a strong barbed-wire fence of adequate height might be constructed between the track and the river. Such a fence will, in my opinion, aid to control the situation and render it much less liable for passers along the track to defile the river in any way, or camp thereon without great difficulty.

Such a fence should be constructed by the city between the power house and Barneston along the right-of-way of its pole line, which would

aid in excluding passers-by. This wagon road carries with it all of the menace of an operating railroad, and what has been said in reference to the drainage and precautions to be observed on the track of the railroad, will apply with equal force to the city's own highway.

Suitable notices should be posted at frequent intervals upon such fence warning people from crossing it, just as fences with such rules are constructed around the reservoirs within the city. It is probable, of course, that malicious or ill-disposed persons will not be entirely prevented from violating the regulations of the city, but such persons have at the present time ready access to the river and stand no chance of even being discovered or controlled.

COVERS FOR BRIDGES

The proposition of flooring the bridges with tight floors would meet with approval, and if it was thought desirable, at such points as the track necessitates, high fences could be erected to prevent the throwing of refuse from car windows directly into the river. The closets of the passenger coaches could be locked while traversing the watershed, as is ordinarily done now in traversing equal or greater distances through large cities and in all depot grounds.

These precautions should satisfy the most captious critic as to the security of the supply from the presence of the trains and track, and it might be suggested that they are much more adequate than are the provisions which are taken to guard against the contamination of the water in the city reservoirs within the city limits from thoughtless or ill-disposed persons.

THE CONSTRUCTION PROBLEM

No great reservoir for a water supply is ever constructed without adequate sanitary precautions. In fact, in these days no great camp of men should ever be gathered together for any public work without adequate sanitary provisions. And it is, of course, evident that construction camps along the Cedar River for twelve to fifteen months, if uncontrolled, would create a situation far from desirable. To admit, however, that adequate sanitary control cannot properly and adequately meet the situation is to admit that we know little or nothing about sanitary control. The progress of sanitary science has been such in the last generation that we have come to a positive knowledge of new dangers which threaten the life and happiness of the general community, and with this knowledge has come also the knowledge of how to properly protect and guard against such dangers. The conduct of camps, the sanitary precautions to be taken in and about them, have been thoroughly studied, with the result that where intelligent authority has been permitted to exercise full sway, all dangers have been entirely eliminated.

RULES FOR CONSTRUCTION

The precautions that should be taken in the construction of the railroad in Cedar Valley would be primarily as follows:

First, the full and complete authority of a competent and educated sanitary officer, with suitable assistance.

Second, the provision for proper location of camps safely away from the vicinity of the river.

Third, care of the camps, so far as the health of the men is concerned, and provision for the purity of their drinking water and food supplies.

Fourth, the provision for suitable conveniences for the men at or near their work.

Fifth, the removal and destruction of human excrement.

Sixth, the removal and destruction of garbage and kitchen waste.

Seventh, the care of draft animals, collection of their droppings and its destruction.

Eighth, provision for bathing purposes.

SANITARY AUTHORITY

Absolute and autocratic authority should be vested in the sanitary officer in charge of the district to formulate such rules and regulations as seem to him necessary for the control of the camps and of the men. It would be proposed as one of the most important of these rules that all actual access to the river be barred; that the wire fences before mentioned, separating the track from the river, be constructed at the earliest possible moment; such special arrangements should be made as will obviate all necessity or desire on the part of the men to visit the stream for any purpose whatever. Such men as refuse to conform to the regulations or show themselves indifferent to their importance, or wilfully disobedient, should be promptly ejected from the camps, and a strong authority should impress upon the working force the fact that sanitation requirements are the first consideration.

All sanitary authorities agree that the best disinfectant for all forms of human waste is fire. This is the safest and easiest method to adopt in a rough country such as we are considering, where fuel is plentiful. Suitable latrines should be built at very frequent intervals along the line of work. An inexpensive crematory can be easily excavated in the bank, consisting of a rough grating immediately over a fireplace upon which the garbage and refuse can be burned as well as the excremental matters. Collections in large camps should be made frequently, and in the outlying and more remote latrines at least twice each twenty-four hours.

Garbage and kitchen waste of the camps should be burned along with the excremental matters. Frequent collections should be made, and no such refuse should be allowed to stand, under any circumstances, many

CEDAR LAKE IN SUMMER

hours. The liquid waste from the cook houses should be led in drains to some safe point where a sufficient area of subsoil can be uncovered so that filtration will be effectually permitted.

Suitable provision should be made around all of the cook houses to protect the ingress and egress of flies which might tend to contaminate the food.

LOCATION OF CAMPS

Camps should be placed at distances at least 500 or 600 feet from the river, on land preferably level, or draining very slightly, if at all. Camps should be provided with a water supply, preferably from springs in the locality, or, if springs are not available, by water pumped up from the river in sufficient quantities for all purposes. It will be exceedingly desirable if the water supply of the camps can be placed under pressure, and suitable shower baths maintained for the use of the laborers, so that there is no desire as well as no opportunity or excuse for them to visit the river for any purpose. A physician should, of course, be provided, who shall watch the health of the men closely and carefully, and any case of sickness from any zymotic or intestinal disorder should be promptly removed from the watershed and all possible contamination carefully disinfected. Liberal quantities of disinfectants should be provided at every camp for the use of sanitary officers, and used under their directions.

SANITARY CONTROL OF CAMPS

Men should be provided whose business it is to constantly keep the surroundings of the camps in a clean and presentable condition. All litter should be removed daily and burned, if possible.

Cleanliness in the bunk houses should be insisted upon. Personal cleanliness should be enforced, and persistently unclean employees should be debarred from the work.

Droppings from draft animals should be collected and burned in the same manner as human excrement. Draft animals should not be permitted to approach any stream entering the river, and always kept under full control.

IN GENERAL

With these precautions properly taken there can be no question that all dangers of pollution to the water supply would be obviated, and that the water supply itself may be entirely above suspicion during all the time of construction. This statement is based on the well-known efficacy of such regulations in the construction of great reservoirs, aqueducts and water supplies, even where such construction was proceeding above intakes already existing. It is also borne out by the experience of cities which purify their sewage and prevent contamination upon rivers, and it is substantiated by experience with military camps and military hygiene.

The history of the military camps has shown an increasing ability to control infection under most unfavorable conditions, and while our own volunteer army medical men did not during the Cuban War succeed so effectually as might have been hoped, they nevertheless learned a bitter lesson of the importance of such matters. Investigations of the conduct of the camps disclosed that important sanitary precautions had been entirely neglected. The typhoid which prevailed in the camps of the American army during the Cuban War is now attributed largely to the pollution effected by flies, which transferred objectionable matter from the latrines to the cook houses. And the lessons which were learned from that experience have been adopted by armies in all parts of the world so effectually that in the recent war between Japan and Russia the Japanese were practically enabled to completely annihilate this troublesome disease as well as to reduce disease in general to the negligible minimum.

It may be remarked that the powers of a private corporation, backed by ample means and accustomed to secure efficient and capable service, unhampered by political influence or cumbersome checks, present an ideal instrument to carry out thorough and efficient sanitary control under proper supervision. So far as I can understand the situation, the interests of the railroad and the city are identical in considering this problem. Neither one nor the other can afford nor should desire to trifle with matters pertaining to the public health. The attitude of both should be that of co-operation and diligence in seeking proper solution and acting on the best knowledge obtainable.

In conclusion, I believe that it is possible to construct a railroad in the Cedar River valley in a safe and sanitary manner without a doubt. I believe, also, that once constructed, such a road, if operated without stations, with floored bridges and locked water closets, and with suitable fencing along the right-of-way, will present no opportunity for accidental contamination so great as exists at the present time. The presence of such additional men as it may bring into the watershed, due to its operation, will be, in my opinion, offset by the increased facility which it will give for patrolling the entire length of Cedar River and for affording the authorities and the public an opportunity to observe the conditions of its source of supply. Dangers which might occur through careless control of the sanitary conditions of the construction forces can be met with proper diligence and intelligent supervision.

It would be quite idle to ask any physician in these enlightened times if he was able to enter a home where typhoid fever existed and successfully cope with the disease in such a manner that no danger to himself or other members of the family could ensue from infection. No reputable medical man would allow for a moment his inability to fully control the situation by suitable precautions founded on long experience and careful study.

The sanitary engineer is dealing with the same problem in a broader way; he is equipped with the same sort of information, the same sort of experience, and the same results of study, which enable him with certainty to control watersheds, water supplies, construction camps, and general conditions which make for the public health. And when authority and intelligence, combined with ample backing, are provided, this successful result has invariably been fully accomplished, just as the domestic problem of typhoid has been put under control.

CONCLUSIONS

1. That in the Cedar River watershed the city of Seattle possesses a magnificent source of water supply.

2. That the city is not now and has not in the last few years properly protected this area from gross pollutions which now exist.

3. That a virgin forest or inaccessible country does not afford ideal protection from pollution, but, on the contrary, a district easily accessible in every part and open to the publicity of frequent inspections and control offers the greatest degree of protection.

4. It is the settled policy, therefore, of most sanitary control of watersheds, while preventing as far as possible the growth of population and the incidental pollution therefrom, to open watersheds freely to the public observation by creating means of access which facilitate inspection.

5. Railroads, so far as the track and trains are concerned, when properly regulated, are not regarded as a menace to the purity of surface water by sanitary authorities.

6. It is through population and industries created by railroads that sanitary difficulties occur.

7. The 25 miles or so of railway now existing in the Cedar River watershed are in themselves no menace to the valley, but the logging camps which they serve are so conducted as to be serious pollutions in many cases.

8. That the operation of a completed railway line by the Chicago, Milwaukee & St. Paul Railway Company on or near the present location can be made entirely safe by some simple precautions, such as fencing, drainage, closed bridge floors and locked water closets.

9. That care should be exercised during the period of construction of the railroad to prevent all access to the water by men or animals. For this purpose the river front should be entirely fenced off, policed, and, where necessary, water should be pumped up to the camps from the river under pressure, and in suitable quantities, for all purposes, including bathing and watering animals.

10. That efficient sanitary control should be had over all camps, cleanliness enforced, refuse of all kinds promptly collected and burned, drainage filtered and commodious and convenient sanitary arrangements provided, and strict control and authority maintained.

11. That the City of Seattle should also fence in the road which it has constructed along the river bank between Barneston and the power house, so as to prevent access therefrom to the river.

12. That the City of Seattle should regulate and control by intelligent sanitary rules the various logging camps now existing upon the watershed.

13. That it woud be highly desirable to prevent decaying wood and vegetable matter from defacing the shores of Cedar River and its important tributaries and to cut off the swamps at the outlet of Cedar Lake and immediately above the intake.

All of which is respectfully submitted.

JOHN W. ALVORD,
Consulting Engineer.

July, 1906.

APPENDIX B

REPORT BY PROFS. A. C. ABBOTT, M.D.; CHARLES HARRINGTON, M.D.; AND WILLIAM T. SEDGWICK, PH.D.—A COMMISSION OF SANITARY EXPERTS—TO THE CITY OF SEATTLE, THE KING COUNTY MEDICAL SOCIETY, AND THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, ALL OF THE STATE OF WASHINGTON, UPON THE POSSIBILITY OF THE CONSTRUCTION, MAINTENANCE AND OPERATION OF A RAILROAD WITHIN A PORTION OF THE WATERSHED SUPPLYING DRINKING WATER TO THE CITY OF SEATTLE, WITHOUT DANGER TO ITS INHABITANTS.

We have been asked to answer two questions: First, whether it is possible to construct a railroad within the watershed of Cedar River, between the water intake and the power house, without danger to the character and wholesomeness of the water supply of Seattle; and, second, whether, in the event of such construction, the road can be operated without endangering the public health of said city through pollution of the stream.

In order to acquire personal knowledge of all the relevant conditions obtaining in and about Cedar Valley, and thus to be able to submit replies based upon something more than general principles and a *priori* reasoning, we have made a careful examination of the area involved, paying particular attention to the configuration of the ground and to the nature of the soil, and we have extended our observations so as to include that part of the watershed between the point where the proposed road leaves it to enter the Snoqualmie watershed and the borders of Cedar Lake. The proposed location of the railroad, as indicated by stakes, has been followed practically from end to end, and the adjacent strips have been examined at such points and to such an extent as seemed desirable or necessary.

We have also carefully examined and considered the various statements and arguments submitted to us.

In view of all the facts, we have no hesitation in answering both questions in the affirmative.

The main question involved in both propositions is whether pollution of the surface of the proposed right-of-way and of the vicinity by the wastes of the human body can be prevented; and, if it cannot wholly be prevented, whether contamination of the river can be guarded against.

It is a well established fact that sewage matters containing myriads of disease germs can be rendered quite innocuous by filtration through gravel and sand, so that, within a short time, and at a distance of but a few feet, the effluent water may have an entirely different character and yield

only mineral evidence of its former bad qualities. This fact was the main reason for careful scrutiny of the nature of the soil.

It appears that, along much of the proposed location, gravel and sand are not to be found. The forest floor appears to be reasonably thick, but at most points it consists almost wholly of combustible matter, and where fires have occurred the soil is shown to be chiefly loose rock, with neither sand nor gravel, and consequently not porous and suitable for effective filtration. At some points along the route, clay and silt deposits are evident, but these materials are not suitable filtering media, for they do not permit percolation. In view of these facts, special provision will be necessary for proper disposal of such waste matters as may find their way to the surface of the ground within and near the limits of the right-of-way during the construction and operation of the road; for without such provisions the said wastes would inevitably be washed into the river in times of heavy rainfall, and, in the event of their containing pathogenic organisms, might lead to disastrous outbreaks of infective disease. The fact is, however, that the character of the water can be adequately safeguarded by the adoption of methods which will be described in detail further on.

The safeguarding of the water supply during the construction of the proposed road is by no means a simple matter, for construction involves the introduction of large numbers of men into the wateshed, whose wastes must be prevented from reaching the river. It will be necessary to establish camps at various places, and these camps must be supplied with water, must be drained, must be provided with bathing and laundry facilities and latrines, and in all respects must be under constant competent sanitary inspection and control far more stringent than, under ordinary conditions, is necessary. It is fortunate that a number of sites for such camps are available, at least 500 feet away from the river, on benches, where the soil, largely gravel, is dry and porous, and hence easily drained and entirely suitable for latrines. Two camps may easily be established outside the watershed; one below the intake and one near the power house and just over the divide, within the drainage area of the Snoqualmie; and between these two points are the several sites above mentioned, on not more than two of which should camps be established.

At the several camps the necessary latrines should be board outhouses placed over reasonably deep pits for the reception of the discharges, which, out of abundant caution, should be disinfected by the application of milk of lime, made from freshly slaked lime, and kept protected from contact with the air. This should be prepared as often as twice per week, since with age it loses in causticity and germicidal power. As the pits become nearly filled, the filling should be completed with clean soil, and new ones should be dug. Between camps, other latrines should be established at intervals of a few hundred feet, and portable privies may be used, which frequently should be cleaned out and disinfected.

Rules relating to the use of these conveniences and absolutely prohibiting the discharge of human wastes elsewhere within the watershed should be enforced with great strictness and under penalty of dismissal. It will be necessary for the future needs of the section hands and others who will constantly be employed, and of the wreckers who may be brought in from time to time as one or another cause and occasion require, to establish privies at reasonable intervals; but for the last mentioned a portable privy carried on the train, with watertight box or tank, would be preferable. Absolute prohibition of bathing and laundry work in the river must be emphasized.

In order that the stretch between the intake and the power house shall receive the minimum possible amount of human wastes, it is recommonded that, while trains are in the valley, all closets be kept locked and that no stops be made except in emergencies, and that no station or round house be established between those points, even with the consent of the city of Seattle by ordinance, so long as the intake of the public water supply shall be below the present power house. Therefore we recommend the amendment of paragraph 2 of Section 2 of the ordinance granting the right-of-way, by striking out the words, "without the consent of the city of Seattle first having been granted by ordinance," and, further, by making the prohibition a permanent restriction in the deed.

For the most complete safeguarding of the water it is advised that, inasmuch as the soil between the location of the line and the river is frequently impermeable, and where made up of loose stone is devoid of the qualities necessary for slow filtration, the roadbed be trenched wherever necessary or advisable, the trenches being filled with gravel and sand, and that dikes be constructed alongside the trenches wherever necessary or advisable.

The necessary bridges should have steel decks, be ballasted with gravel and sand, and be provided with means for drainage, and the water drained off should be conducted to points at least 50 feet from the river bank on each side, and discharged over appropriate areas or into gravel pits.

During construction the entire area affected should be under the unhampered supervision and control of a competent sanitary engineer appointed by the city of Seattle and approved by the state board of health. He should be empowered to employ, with the approval of the state board of health, as many inspectors to act as sanitary police as the state board may deem to be reasonable, and he and they should be given all of the powers of special police. He should be required to employ one or more registered physicians as medical inspectors, who should examine and report to the board of health of the city of Seattle upon all cases of illness, and cause the immediate removal from the watershed of all persons found to be sick of infective disease.

We recommend, therefore, the amendment of paragraphs 3 and 5 of Section 2 of the ordinance granting the right-of-way, so as to provide for these measures of sanitary protection.

After construction and during operation, so long as water shall be taken from any point below the present power house, the roadbed should be under the constant supervision and control of a competent sanitary inspector appointed by the city of Seattle with the approval of the state board of health, and the section hands should be required to remove and properly dispose of such obvious polluting material as may be discovered.

We feel that we should be remiss in our duty as sanitarians, although the matter is one beyond the scope of our employment, were we to neglect to call attention to the necessity of protecting the water supply of the city from possible dangerous pollution of far greater importance than any likely to be caused by the operation of a properly constructed and efficiently guarded railway.

The selection of the Cedar River watershed as a source of water supply was an eminently discriminating and wise act, inasmuch as Cedar Lake and the entire watershed are capable of yielding an abundant supply of pure, soft water. Especially commendable are the steps which have been taken to secure ownership by the city of the banks of Cedar River and Taylor Creek. But the city is apparently unaware of the fact that in using the water of an only partially protected running stream, without storage, it is exposing itself to the danger of a possible outbreak of typhoid fever or other water-borne infective disease. Contrary to common belief, founded on a mistake made by a commission who studied the subject of pollution of streams before the present methods of scientific examination were devised, the water of a rapidly moving stream does not lose its dangerous properties in a run of a few miles after it has received a specific contamination, and it is especially dangerous when this specific pollution has been discharged directly into it or has been washed into it before the action of sunlight and other agencies have destroyed the contained disease germs.

In the course of our examination, fishermen were observed here and there along the banks of the river, and in the woods near the stream were occasional evidences of occupation by camping parties. The danger of wholesale infection from the chance discharges of a single one of such trespassers is, indeed, slight; but it is a real danger, nevertheless, and when unrestricted access to the river is permitted, it becomes multiplied. We are informed that the city is taking steps looking to the abatement of local nuisances within the watershed, but we feel that it is not doing enough, and will not do enough, until fishermen and all others who have no real business along the city's water supply, or who are not under sanitary supervision and control, are warned off and dealt with as trespassers. Better yet would be the construction of a large impounding res-

ervoir, between Cedar Lake and the power house, as proposed by the city engineer, and the bringing down of the water in mains from that neighborhood, thus gaining the advantage of a stored water.

Respectfully submitted,

A. C. ABBOTT.
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APPENDIX C

REPORT TO THE STATE BOARD OF HEALTH OF WASHINGTON UPON THE SANTITARY ASPECTS OF A GRANT OF RIGHT-OF-WAY BY THE CITY OF SEATTLE FOR A RAILROAD ALONGSIDE THE STREAM FROM WHICH THAT CITY DERIVES ITS PUBLIC WATER SUPPLY

By John R. Freeman, Consulting Engineer

1. The question is: May the city of Seattle, with due regard to the public health, grant a right-of-way to the railroad in close proximity to the river above the city's intake for a distance of ten miles, through lands acquired by the city for the protection of its water supply; particularly in view of the facts that this river flows rapidly and that there is no detention reservoir of size large enough to detain the water a sufficient time to permit germs of typhoid to die, and no filtration works to remove them?

2. My answer is that this right-of-way may be prudently granted if proper safeguards are provided, in rigorously caring for the construction camps, in moving the railroad location somewhat farther back from the river at certain points, in carefully designing culverts, bridges, and ditches, and by providing other safeguards to be described later in detail, and all of which I believe are entirely feasible.

3. The conditions surrounding the water supply of Seattle are, in respect to detention reservoirs, materially different from those at nearly all important cities that use surface water and have railroads, highways and villages within their watersheds, and retain a low typhoid death rate.

4. A detention reservoir, in which water from the flowing stream must be stored for a month or more before passing into the distribution pipes, is one of the greatest of all safeguards in a surface water supply, and to cite the absence of injurious effects from railroads in watersheds from which the water is stored is misleading as a precedent for Seattle in the proposed location of this railroad.

5. Seattle's water supply is in many ways one of unusual excellence; it is of a very remarkable transparency and freedom from color, and therein is probably not excelled by any large water supply in America and is equaled by very few. It is, in fact, mainly water flowing from springs.

In its selection and method of first development, excellent judgment and engineering skill are shown. Its few shortcomings are mainly those incident to newness and rapid growth, and are such as doubtless will be remedied as the city grows, and as fast as the engineer is given the means. I learn that the city engineer has already outlined plans for its improve-

ment, and I doubt not that this Cedar River source can be so improved and developed as to give to more than five-fold your present population one of the finest water supplies in the world. Plainly its purity should be jealously guarded.

6. The fundamental facts on which the answers to the present main question turn are the following:

7. If a single discharge from the bowels (or from the urine) of a person in the early or "walking" stages or the convalescent stages of typhoid fever falls into, or is soon washed into, any tributary of a flowing stream so that it reaches the distribution pipes of a city within a period of two or three weeks, the thousands or millions of the germs in this one pollution may become so scattered and diffused as to enter many households, and, possibly, finding lodgment in the intestines of those persons whose vitality or power of resistance is low, may bring disease to a hundred and death to a score or more of citizens.

8. The second important fact is, running water does not completely purify itself from disease germs. The three safeguards opposed to the above are:

9. *First*, that the chance is very rare of perfect connection of the necessary links in the chain of circumstances between the dropping of the pollution and its seeds of disease being sown in the human system.

10. *Second*, that nature has a wonderful process of purification in natural filtration of polluted water by the wash from such material slowly through moderate depths of sand.

11. *Third*, that after a period of two or three weeks of immersion in stream or pond, most of the disease germs die, and that for most kinds of bacteria, sunlight is a great germicide. The coolness of this spring water, its running and aeration as it flows in this turbulent stream, all tend toward safety. The precise period of detention necessary for safety, the full list of water-borne diseases (which certainly comprises typhoid, dysentery, and cholera), and the life-history of these germs, present important problems not yet fully worked out by pathologists and bacteriologists, but we may believe the main facts stated above as proved beyond all doubt or question.

12. It appears well proved, also, that some kinds of disease germs survive drying and transportation in dust, but the greatest danger to a drinking-water supply lies in the water-borne germ, less than two or three weeks old, from the bowel discharge of a human being suffering with typhoid.

Lest some timid person be unnecessarily alarmed at the possibility, by not giving due regard to the probability, I venture a comparison with Providence, R. I., an old, wealthy, and cultivated city of substantially the same size as Seattle. It has for many years taken its water directly from the flowing stream into distributing reservoirs of moderate size, pre-

senting only three or four days' detention, and not until within the past year have its filtration works been completed. The number of inhabitants per square mile on this Providence watershed is 315, which is nearly 100 times as great as on the Cedar River watershed of Seattle; and railroad lines with frequent local trains pass along the porous, sandy margin of its river, without thought of special protection or closing of closets, for distance aggregating more than ten miles and with seven bridge crossings. Its last typhoid epidemic was about seventeen years ago. This was traced to a case of typhoid on the watershed, but I have not the details at hand.

On the other hand, the possibilities of the number of cases for which one or a very few sick men can sow the seed, have been shown in a remarkable way at Plymouth, Pa.; Waterville, Me.; Windsor, Vt.; New Haven, Conn.; Ithaca, N. Y.; Chelmsford, Mass.; and elsewhere.

13. These facts have come to be understood and fully proved only during the past ten to twenty years, through the profound and patient researches of a few small groups of bacteriologists, pathologists and engineers, and unfortunately have not all of them yet become widely diffused as matters of common knowledge.

14. This is particularly true as regards the danger that may lurk even in the transparent, attractive water of a pure mountain stream that has become accidentlly polluted.

DANGERS IN WATER SUPPLIES FROM RUNNING STREAMS WITHOUT DETENTION OR FILTRATION.

15. Years ago, before the recent science of bacteriology was born, a commission of English sanitarians, working from the chemist's point of view, was led to report that a flowing river did tend to purify itself and that its impurities became oxidized.

This is to some extent doubtless true. I doubt not that the water from Cedar Lake, with its many slowly decaying trees, stumps, logs, and weeds, is improved as it tumbles over its steep course of ten miles to the intake, and that any deleterious effect of the jams of dead logs and tree tops along the stream is thereby lessened. Bad odors from decaying organic or vegetable material are shaken out and oxidation is promoted in water running over such a course.

The half-truth of stream purification became widely circulated and today continues to do harm, while ten times over it has been proved that typhoid epidemics are so carried, and that from a single case along the tributary 100 or 1,000 citizens farther down the line may suffer.

16. It has been found by later studies that water that has been held long in storage is far safer than running water as a source of domestic supply, and the large new supplies of Boston and New York, for example,

are being developed with reliance upon this principle of detention for protection against the unavoidable minor pollutions.

Other cities where detention reservoirs are impracticable, for example, Philadelphia, Pittsburg and Providence, are now constructing great filter plants. So strong is the teaching of recent science and practice concerning the economic value of this safeguard, that I venture the prediction that Seattle will ultimately, perhaps twenty years hence, come to filtration, unless later surveys shall demonstrate the feasibility of a large detention reservoir, or shall show that sufficient water can be taken by infiltration galleries or large wells directly from the remarkable series of springs which enter the river a few miles up stream from the intake.

For there are various possible sources of pollution already existing in this watershed, such as may produce typhoid, and while some are in process of remedy, others will continue or possibly increase during the many years of lumbering, regardless of whether the St. Paul road comes in or not; indeed, the beauty and attractiveness of this region will tend more and more as time goes on to bring sportsmen, fishermen, campers and strollers into this watershed.

THE CITY'S WATERSHED

17. It is only five years since the city of Seattle abandoned its unsatisfactory Lake Washington source and went back about 25 miles into the forests and foothills of the Cascade Mountains and built an intake and diversion dam on the Cedar River, at about 550 feet elevation above sea level, and from this point to the city constructed a wood stave pipe hooped with iron, 42 inches in diameter. The diversion dam raised the river but little more than fifteen feet and flowed back for so short a distance and so narrow a width that the time of detention in the pond thus formed is hardly more than two or three hours, with the mean annual rate of river flow, and not more than half a day at the time of minimum flow.

The city engineer gives the following data:

The city now takes out about 23,000,000 gallons daily, equivalent to about 35 cubic feet per second.

The population supplied, including certain suburban districts, is nearly 200,000.

The present per capita consumption is thus about 115 gallons daily.

The smallest flow of the river at the intake has been found in October, and in the year 1904 amounted to 154 cubic feet per second.

This minimum flow is 4.4 times the average quantity now drawn by the city.

In years of smaller rainfall a smaller river flow may be expected, but just how small cannot be stated from the data thus far collected, which are very scant.

The total watershed area above the intake is at least 139 square miles and may possibly be 145¾ square miles.

This is made up of two areas of different characteristics, although both are heavily timbered. The upper area is more within the mountains than the lower, and comprises a little more than half the whole, its area tributary to the proposed future high dam being 75 square miles. All of this upper watershed is more than 1,500 feet above sea level and is nearly surrounded by mountains, which increase its average rainfall above that observed in the rain gauge at the lake; so that this upper half of the drainage area receives more than double the depth of rain that falls on the lower half of the watershed.

The record of 1904 gave for the total annual rainfall at Cedar Lake, at an elevation of about 1,530 feet, 94.4 inches.

The total inches of rainfall during the year 1904 at the intake at an elevation of about 550 feet above the sea was 48.6 inches.

When the whole area of 145 square miles is considered, it appears that the watershed is being rather slowly logged off, so that ten or perhaps twenty years may elapse before the lumber camps will be withdrawn.

The ground in those portions not yet logged is covered with a sponge-like humus of decaying vegetation, probably six inches deep, which absorbs and restrains the rainfall from rapid run-off, but the fires that appear inseparable from lumbering as now conducted destroy this humus and leave the ground almost bare and sterile.

Cedar Lake for the upper portion, and the vast gravel deposits for the lower portion, will, however, continue to regulate the run-off from the watershed sufficiently for the city's purpose.

The city has already purchased about one-tenth of the entire watershed, this being confined mainly to lands bordering on the streams and the lake. These purchases are in some cases subject to mineral rights and the possibility of future coal mines, and in some cases a right-of-way for future possible branch railroad lines has been reserved.

The city proposes to purchase additional areas as fast as these are logged off, and has arranged with the general government to have certain of the lands not yet sold withdrawn from sale, so that ultimately the city will own substantially its entire watershed.

It is of interest to briefly review the conditions of yield and storage for the purpose of learning if the intake at the water works could be moved up-stream.

The present temporary dam at the outlet of Cedar Lake gives at elevation 1,530 feet above sea level a storage reservoir of 1,300 acres area and 746,000,000 cubic feet capacity. A most excellent dam site that exists a mile or more farther down the stream will permit a high dam to be constructed, raising the level of the lake 60 feet, or to an elevation of 1,590 above sea, giving a storage reservoir of more than six times the present volume, or of 1,850 acres, and 4,835,000,000 cubic feet capacity.

Upper Falls Cedar River

This is equivalent to 36,000,000,000 gallons of storage, or half a year's supply for 2,000,000 people, without rain meanwhile.

Before one can state with certainty just how great a constant uniform draft this watershed can be made to supply, an extended study must be made of all Puget Sound rainfall records, and more observations must be had upon the rainfall and evaporation within this mountain region; and there may be remote possibilities of some escape by percolation through old channels filled with porous glacial deposits.

As a rough preliminary figure we can safely reckon that these two watersheds above the city's present intake will be sufficient for all reasonable uses of a population somewhere from five to ten times as great as Seattle now possesses.

The lower half of the watershed, or that immediately up-stream from the intake, is said to be different from the upper in geological character, consisting mainly of a vast deposit of porous gravel, presumably an outwash plain from the mountains, or of glacial origin.

A comparison of the measured flow of the river near the intake with the flow at the outlet of Cedar Lake also brings out the characteristic difference of these watersheds.

While the natural yield from the upper watershed is said to fall to a minimum of about 30 cubic feet per second in August, the minimum flow at the intake dam is not reached ordinarily until October, and in 1904 was found to be 154 cubic feet per second, thus showing a yield from the lower 70 square miles at time of minimum flow more than four times as great as from the upper 75 square miles. Plainly the cause of this is the absorption of the winter's rains by the porous gravel deposit of the lower watershed to be stored and slowly given out by percolation to the many large springs near the bottom of the valley. These vast gravel deposits thus take the place of a storage reservoir for the lower watershed and increase its available yield.

18. It will be seen from the foregoing that to seek to avoid pollution by extending the city's intake pipe back to the power house, and thus virtually to the lake, would throw away nearly half of the available watershed area, and an area from which the water is rendered particularly transparent and pure by reason of its natural filtration. All of this watershed will be needed at some future time.

The higher dam would have to be built much earlier if the city's intake were extended farther up the stream, for the minimum yield from the upper watershed is stated to be, under present conditions, only 30 cubic feet per second, while the city today is using 35 cubic feet per second.

In view of the fact that the normal minimum yield at the present intake is 154 cubic feet per second, or more than four times as great as the present draft by the city, it will be possible to defer the expensive high dam for a number of years by continuing to draw largely from the lower watershed.

19. As the demand for power from the municipal power plant increases it will become more important to have a larger storage reservoir near the present intake than that which now exists.

The demand for power varies greatly at different hours of the day, but the delivery of the aqueduct to the city reservoirs should be nearly constant. Wherefore an equalizing reservoir near the intake to the aqueduct will, at some future time, become necessary.

DETAILS OF PROPOSED RAILROAD LOCATION

20. Coming now more into the details of the problem at hand, we find that the railroad, after running many trial lines, has finally staked out a line of location closely following the river for about ten miles and twice crossing it, and also crossing the large tributary of Taylor Creek. This line runs in some places as close to the water's edge as the steep slope of the high embankment will permit, or so that the water would wash the foot of the steep slope, and riprap be required to hold it, but in general the center line will be nearly 100 feet distant from the water's edge, and for perhaps one-fourth of the entire distance will be several hundred feet distant.

A view of the plan, showing the distance between the center line and the water's edge, does not tell the whole story of proximity unless one takes account of the width of roadbed and the width of the steep sloping embankment and of the somewhat nearer water line in time of flood.

21. The formation along the river near the desired location is mainly a vast glacial deposit, showing broad, deep terraces of gravel, for the up-stream five miles, but with apparently an increasing amount of boulders and angular stones for the down-stream portion, so that as far as can now be seen before the ground has been cleared and burned, there will be a very scant bed of sand or fine gravel suitable for natural filtration of the wash from the roadbed along perhaps two miles of the line.

Within a distance of two or three miles up-stream from the intake are many flowing springs breaking out from under the terrace near the foot of the proposed railroad embankment, and the natural surface of the railroad center line is in many places moist, making it probable that when the railroad ditches are cut water will stand or flow continuously in the ditch beside the track at the foot of the inner slope.

22. It is plain from tramping along this railroad location line as now revised that an earnest effort has been made by the locating engineers to keep it farther away from the water than would be the custom under ordinary conditions, and it is plain that increased cost is already incurred in lessening the length of roadbed on embankment sloping directly to the river, by moving the line farther back so that a considerable portion of the roadbed is in a cut.

23. But it is also plain that the line can, at somewhat further increase of cost, be pushed still further away from the river, and that in many places more of the roadbed can be made in shallow cut, so that there will be a natural earth dike between the roadbed and the river through which the natural drainage and rainwash will filter.

24. I am convinced that it is entirely reasonable for the city, as a condition of granting this right-of-way, to insist that the railroad be pushed back from the water to the very limit, and I find that the extra excavation thereby required will be mainly in gravel of loose, easy character, with some loose rock, but with little or no ledge, and the extra cost not at all exorbitant, so far as can be judged from the surface as now seen prior to clearing.

25. Many other precautions and safeguards not found in ordinary railroad construction should also be made a matter of definite agreement, competent inspection, and absolute enforcement, beyond the terms as they stand today in the ordinance granting the right-of-way. These will be described more in detail in the following pages.

In part it should be required that a dike of sand or gravel, say at least three feet high by four feet top width, be built and forever maintained between the roadbed and the river at all places where this is on the embankment.

Preference should everywhere be given to a roadbed in cut, so as to secure a natural dike, and, in brief, the most complete precautions should be taken regardless of expense, that any rainwash or polluting material falling on the roadbed will be safely filtered before reaching the flowing stream.

Although the chance of infection is small and remote, it is nevertheless possible and certain, and we may well remember the instance of Plymouth, Pa., for example, where it appears to have been proved that more than 1,000 cases of typhoid, with 114 deaths, resulted from the dejecta of a typhoid patient being thrown on frozen ground on the banks of a stream in a watershed that was almost uninhabited.

REASONABLENESS OF CEDAR RIVER LOCATION WITH SAFEGUARDS GUARANTEED.

First having a guaranty of the safeguards which can readily be provided and which can surely be enforced, I am led to conclude that the city of Seattle may prudently grant the desired right-of-way and that it would be unreasonable to withhold it, because of the waste in construction and operation that the best possible alternative railroad location involves, and for all of which waste the commercial interests of Seattle would ultimately have to help pay.

The risks in sanitation that will remain from the presence of the railroad after the prescribed safeguards are rigorously provided will, I

believe, be of the microscopic and academic character that we continually have to accept; indeed, it can be figured out that the chance of pollution from the railroad after providing reasonable safeguards will not be one-tenth as great as from other sources of possible pollution in lumber camps, sawmill settlements, strollers along the stream and in the branch railroad, all of which exist today and some of which will continue to exist indefinitely, and which, taken all together, are, after all, small in proportion to those that are found along the water supplies of many cities without serious epidemics.

Those fond of figures may be interested in the following computation:

Suppose 1,000 different passengers per day to pass through the Cedar River watershed on the St. Paul road; this is 365,000 per year. Health statistics of Massachusetts (the most complete in the United States) show 1.24 cases of typhoid per 1,000 inhabitants per year. Convalescents and those who have the disease in a mild form, in the first week or two of the disease, may travel. We can at most assume that 450 out of all these 365,000 passengers would have typhoid at some time during the year. Calling the duration of those stages of the disease within which one could travel a month, or one-twelfth of a year, we can expect only 37 persons actually in the infectious stages will travel over the road during the year.

If these have so many as four stools per day, the chance is that in the twenty minutes (or one-seventy-second of a day) occupied by ordinary trains passing through the watershed, these 37 cases would produce: Thirty-seven cases multiplied by four stools, dived by 72, equals two stools per year on track; or the probability is that only two discharges per year of excreta from typhiod patients are likely to be dropped on this entire ten miles of roadbed from passengers.

When we consider that one of the residents of a lumber camp sick with typhoid may have an average of say two stools per day (we have figured twice this for the passengers), or say at least 50 stools during his entire illness, this is 25 times as many as we figure out as likely to come from all the passengers in a year.

With 500 persons resident in the watershed, the probability is of only .62 cases of typhiod per year among them, and, of course, most of these residents are remote from the stream.

Figuring it in another form, and assuming the domicile in as close proximity to the stream as the track: A resident population of

$$\frac{2 \times 1{,}000}{50 \times 1.24} = 32$$

persons would produce the same chance of infection that will be presented by 1,000 passengers per day on the trains.

26. I am told that the best alternative railroad location outside of the watershed or not alongside the city's source of water supply will require from five to seven miles greater distance and necessitate a ruling gradient 0.25 per cent steeper eastward for nearly twenty miles, approaching the mountain division, adding that much to the distance over which helper engines must run; and that, in addition to the greater length, sharper curves, which tend to limit speed, must be used, and that much more expensive trestles and high embankments must be built, and that some adverse gradient westward would also have to be incurred.

27. With the desired line down Cedar River valley, a continuous grade of eight-tenths of 1 per cent can be secured and the curves need nowhere be sharper than 3 degrees, permitting high-speed passenger service with outer rail elevation adapted also for low-speed freight, and the lay of the land, its slopes and stream crossing nowhere invite slides or washouts.

POSSIBLE DANGERS TO BE GUARDED AGAINST

28. The construction of this ten miles of railroad alongside the city's water source introduces the following specific dangers to be guarded against:

(*a*) For about a year's duration construction gangs aggregating about 500 men will be employed along this ten miles of river, thereby not only doubling the present total population, but placing all of these new men very near to the main stream. There will also be many camp followers and tramps.

(*b*) At the foot of the steeper eastward grade, near the city's power house, a station for helper locomotives will be established, with a round house and a few residences, which will increase as the business of the railroad grows. It is feasible to locate all of these buildings so that although located within 200 feet of the river their drainage can pass down an ancient channel into another stream, because of the very peculiar lay of the land at this point. But the bringing of this additional population brings more persons who will fish, hunt, or stroll along the nearby stream and who may chance to some time thoughtlessly pollute it.

(*c*) After the road reaches the operating stage, the passenger trains and freight trains will continually carry more and more, and with human nature as it is there will always be the chance of dangerous pollution dropped on the roadbed by those in the early stage of typhoid, dysentery, or other disease, in spite of the rules to lock the toilet rooms during the one-third or one-half hour occupied by a train in passing.

Freight trains and sometimes passenger trains will be detained on the long siding midway.

(*d*) From six to ten section men will be continually engaged in maintenance work on this ten or eleven miles of track close to the river.

(*e*) By opening up the country and making it more accessible to fishermen and sportsmen and picnickers, a railroad will be the means of bringing more people along the banks of the stream.

(*f*) Tramps, careless and reckless of regulations, will probably, in course of time, follow the railroad line.

(*g*) Double tracking or new bridges, wrecks or other work bringing in large gangs of workmen, are all likely to come in course of time.

29. The safeguards against the possible danger of pollution from the causes just described are all matters of simple care and common sense, all centering around the idea of keeping people out of the watershed or away from the tributary streams so far as possible, and of so placing camps, latrines, sidings, and main roadbed that the rain-wash from any defections or other pollutions will filter through a safe thickness of sand or fine gravel before it reaches the stream, and that all these localities shall be so far removed from the water or so shielded as to practically remove the chance of dust containing any of these germs from being blown into the water.

SANITARY OVERSIGHT REQUIRED

30. The detailed specifications for much of this work cannot be properly made until the 100-foot right-of-way has been opened up and enough of the cut made to disclose the character of the ground for filtration, and whether flowing springs develop in the hillside districts; therefore the oversight of the whole matter should be placed with some competent sanitary engineer, working under authority of the city of Seattle and the state board of health, who should, from time to time, go over the line as construction progresses, in consultation with the chief engineer of the railroad, to frame such detailed specifications as may be demanded by the character of the ground.

The supervising sanitary engineer should have his deputy continually on the ground during the progress of the work in the person of the chief sanitary inspector.

During the year of active construction this chief sanitary inspector will require the services of three or four deputies to look after the details of sanitation properly. At least one of these should be a physician skilled in the detection of typhoid and who should keep close watch of the health at the several camps. The entire line where work is going on should be patrolled twice daily.

After the construction period is over an inspection should be made at least once a month over the entire length of the railroad line of the St. Paul and also over the present Northern Pacific branch railroad. The sawmill village and the several lumber camps and the shores of the main stream all the way above the intake should also be inspected once a month by some one trained in sanitary science, and a record made on a carefully

prepared blank, giving the conditions found, should be placed on file with the city water department.

31. Three or possibly four construction camps will be needed during the building of this ten or eleven miles. Two of these camps can be located outside of the watershed, one at either end.

There are admirable locations for the one or two intermediate camps at points where the roadbed is located upon a bench several hundred feet back from the river.

32. Each of these one or two camps within the watershed should have its water supply piped in for drinking, cooking, and washing, and with hot water also on tap. This camp supply in general should be made more convenient than to visit the river for water. Deep pits should be dug into which all drainage from washing and cooking should be led to slowly filter away. Numerous light wooden privies that can be readily moved should be built and placed over pits, and these should be regularly disinfected by lime and slowly refilled with earth. A barbed wire fence of double strength should separate the camp from the river. Before occupancy the camp ground should be cleared of all trees and underbrush and the space between the camp and the river should also be cleared and burned for a half a mile each way along the line so as to remove all cover.

Then with a sufficient number of sanitary inspectors and the prompt discharge of offenders, it will be entirely feasible to make the camp safe, as has been done on recent large work for the city of Boston close beside its water sources, where many foreign laborers were employed.

It should be made a part of the contract between the city and the railroad that any laborer, foreman, or other employee caught transgressing the sanitary rules will be immediately dismissed; and if one or more of the sanitary inspectors be given authority of a constable to arrest any offender against the health ordinance, it will help.

LOCATION OF RAILROAD FARTHER BACK FROM RIVER

33. A relocation of the railroad line farther back from the river is the first work demanding attention.

To do this important work in the best manner and as a basis for laying out the further safeguards, a new survey map should be made on the scale of 100 feet to the inch, utilizing all present topographic notes and immediately putting surveyors in the field to extend the contours to cover with greater precision all of the ground between the road and the river and to reach up to the top of the terrace.

ENLARGED DETENTION RESERVOIR AT INTAKE

34. The railroad grade may need to be placed at an elevation perhaps twenty feet higher (more or less) than it has yet been located, where it crosses the intake pond of the city water works, in order that the city may not sacrifice its opportunity to construct more of a detention and equalizing reservoir at the intake. Reference has already been made to its importance at some future time, for equalizing the irregular draft of water for power, so that it may be taken into the water supply conduit at a uniform rate, and whatever can be gained in detention of the water from the rapidly flowing stream before it enters the city's supply will be an advantage.

Surveys and studies on behalf of the city are needed to find out just how far such an enlargement of the present intake pond is feasible. The railroad's line as now surveyed is understood to permit little or no enlargement, and its engineers will naturally be opposed to raising the grade at this point.

Apparently no very good opportunity exists for a sufficient detention at the intake, this being complicated by the fact that the flood flow is many times larger than the city's present rate of draft; but this condition will change somewhat as the city grows and the Cedar Lake storage capacity is largely increased, and the matter is well worth the cost of immediate surveys and studies before the railroad makes the larger reservoir at this point forever impracticable.

CLEARING GROUND BETWEEN THE RAILROAD AND THE RIVER

35. The trees should be cut, the logs removed, the stumps and dead wood burned, for the entire 100-foot width of right-of-way of the railroad. The ground between the railroad and the river should all be similarly cleared and kept cleared, the object being to remove all cover and to permit easy inspection from the railroad and the prompt discovery of any trespassers.

The city, for its part, might also completely clear a strip 100 to 200 feet wide on the opposite bank, also for the purpose of removing cover and for making its sanitary patrol easy and efficient.

The value of shade for keeping the water more cool is mainly fanciful and far less than the value of the sun as a germicide. Ease of inspection is one of the greatest of all safeguards.

FENCING

36. A barbed wire fence should also be built along the inner boundary of the railroad's land as soon as the work of felling trees, burning and clearing is completed. This fence should be extra strong and tight, its object being to impede access to the water of tramps, railroad section men,

Cedar Lake Basin

or those who may leave the trains in case of accidents or detentions at sidings.

Should it be concluded that it is too much to ask for the maintenance of such a fence over all of this ten or eleven miles, it should certainly be insisted upon for a strip nearly a mile in length near each construction camp and near the permanent siding.

CULVERTS

37. Culverts, preferably of cast-iron pipe, of ample size, with tight joints, should be laid safely below frost, and for the entire 100-foot width of the right-of-way, for all small streams, flowing springs, and gulleys that give evidence of stream flow in time of rain.

An effort should everywhere be made to protect these small natural streams that cross under the roadway from any possible rain-wash of polluting material dropped on the railroad right-of-way by passenger, tramp, trainhand, or workman.

SIDE DITCHES AND DRAINS

38. Where the railroad cut lies through moist ground, so that water percolates into the ditch on the uphill side, forming at times a running stream along the ditch, the ditch should be deepened about three feet or more, according to circumstances, and have a width of at least two feet. In the bottom of this trench vitrified drain pipe, not less than six inches in diameter, and generally more, according to extent and length of water found, should be laid with open joints, surrounded and covered with coarse gravel for at least one foot in depth, and over this filled with fine gravel up to the ordinary form of a railroad side ditch. This drain pipe should be extended a sufficient distance through dry, porous gravel to permit the water thus collected to filter away through a safe distance of not too coarse earth before reaching the river.

39. There are several localities within this ten miles where, so far as can today be seen, the ground will be found so rocky after the humus is burned off that it will perhaps prove unsuitable for filtering material. This is particularly true at several points within two or three miles of the intake. At such points the rain-wash from pollution dropped on the road ballast might fail of proper detention and purification unless ditches and drains are constructed as described in the preceding paragraph. It may, after further investigation, be found best to carry large drains of the type just described down stream from localities near the intake so that they will discharge below the watershed limits. The fact that the grade of the railroad descends without interruption at the rate of about 40 feet per mile for the entire distance of the ten miles makes drains of this kind feasible.

The details of side-ditches and vitrified pipe drains and the gravel covering them will have to be studied out on the ground after its character has been more fully shown up by clearing off the timber and dead wood, burning off the humus, and making the main cut.

SIDING

40. Only one side track for passing trains is desired within this ten miles. An excellent site for this is found on a high bench or terrace of gravel nearly opposite the sawmill village of Barneston. At the site of this siding the railroad line should be crowded against the hill so as to give greatest possible distance from the river. By so doing a distance will intervene that can be regarded as entirely safe.

To provide against possible pollution during the long detention of freight trains here, three or four small, neat privies should be constructed along the line over pits dug deep in gravel, and the whole properly cared for as part of the regular maintenance work of the section gang.

Here and at all tool houses for the section gangs it may not be amiss to pipe from the small spring on the hillside so as to give a convenient drinking-water place, and to lead the drainage therefrom into a blind drain in the porous gravel.

A location about a mile below Barneston also furnishes a favorable site for one of the construction camps and for a tool house and headquarters for the section gang.

The ordinance should forbid any regular station on the railroad within the watershed.

SECTION GANGS

41. After the railroad construction is finished and the road is in operation, its maintenance will require the continual services of, say one and one-half section gangs for this ten miles.

It can doubtless be arranged that only one gang will have its headquarters and its tool house within the watershed limits, while the ends are cared for by the gangs domiciled just outside.

Conspicuous notices, in large type, should be placed in all the section tool houses for each of the three gangs that work within this watershed, directing attention to the preservation of the purity of the city's water supply. Small, neat privies over deep pits should be maintained, at convenient intervals, for the section gangs along the entire ten miles of road within the watershed, to the satisfaction of the city's sanitary inspector, and the section men should be instructed to bury, immediately, any polluting material found on the track.

BRIDGES

42. It is already prescribed in the ordinance that the bridges are to be tight deck bridges. The St. Paul road crosses the main river twice within the watershed and makes an equally important crossing of Taylor Creek, which is also a large, rapidly flowing stream.

It would be almost impracticable to secure by ordinary methods of railroad bridge construction a deck so tight that heavy rain would not wash pollution through it or around the end of its parapet back into the stream.

Special care, therefore, must be given. My recommendation is for a reinforced concrete arch bridge at each of these three important crossings, having the top of its arch, say, at least two feet below the bottom of the ballast and with a space over the arch filled with moderately coarse porous sand, such as will afford good filtration. The side parapets should be carried up four feet above the rail and extend for at least 50 feet into the bank beyond the high water line.

The smaller creeks and the channels that run strong in time of heavy rains should each be the subject of a somewhat similar precaution.

HELPER-ENGINE STATION

43. Near to the city's electric power station, but just outside the city's watershed, there will be located a small round house for locomotives used to help trains up the heavier eastward grade that begins near this point. The lay of the land here is so peculiar that, although distant but a few hundred feet from Cedar River, all of these buildings can be made to drain outside the watershed, and the only danger is that as business grows and the station becomes larger, men off duty, or members of their families, will stroll along the river and might thoughtlessly pollute it. It will doubtless be sufficient for the city to require the maintenance of an extra strong and tight barbed wire fence along the railroad location here, and to post conspicuous notices asking for thoughtful care in preserving the purity of the water.

ANTI-POLLUTION NOTICES

44. It will be useful for the city to prepare a large number of conspicuous notices, printed on cloth in very coarse type, briefly asking the cooperation of all who walk along these portions of the river to lend their aid in preserving the purity of the city's drinking water supply, and to nail these to posts and trees all along the line of Cedar River, and also along those creeks and valleys that pass near to the lumber camps.

Such a request for friendly aid will doubtless be as efficient as posting copies of the health ordinances with a description of the penalties.

LOCKING OF PRIVY DOORS ON CARS

45. Representatives of the railroad have offered the suggestion that the closet doors could be locked during the times that trains are passing over this ten or eleven miles of track within the city's watershed, and, perhaps relying on this safeguard as sufficient, had not proposed such extensive structural precautions as I have outlined above.

It appears certain to me, after careful consideration of the known facts regarding typhoid and of the epidemics that have been plainly traced to pollution of a flowing stream, that the safety of the citizens of Seattle demands the more certain, although much more expensive, safegaurds herein recommended.

The time of crossing the watershed by a passenger train on an up-grade might often be nearly half an hour, and for a freight train the period would be longer, and still longer periods within the watershed are probable in case of detention at the siding waiting for a belated train, or while waiting for a clear track after a wreck.

Persons coming down sick or homeward bound with typhoid or dysentery, or in the early and unrecognized, but infectious, stages may be among the passengers, and it is too much to expect or to require that the door would always be kept locked against urgent need.

Detachable pans under the car closet may possibly, at some future time, come into use, as is now being done on some Germain railroads, but it is too much to expect that their use could be relied on on all sorts of cars on this ten-mile run between unimportant stations out in the woods. The only safe way is to safeguard the roadbed construction on the theory that closets will often be left unlocked, and then add to the safety by keeping them closed as much as can properly be done.

REMEDY OF EXISTING POSSIBLE SOURCES OF POLLUTION

46. My own examination was confined to the proposed St. Paul railroad line and the territory adjacent thereto.

Whatever chances of pollution may exist today, there is plainly no justification for an increase in the chance of pollution, and therefore I did not consider that the present question required me to seek out the various settlements in the watershed or to inspect the lumber camps, but at Barneston our party spent the night, and thus had opporunity to note existing conditions.

I am told that there are now about 500 persons resident within this watershed. This is a remarkably small number per square mile as city watersheds go, and would not give rise to serious apprehension except for the fact that the city takes its water directly from the rapidly flowing stream and that a part of this population, at least, resides in undesirable proximity to rapidly flowing tributaries.

At Barneston the village of the Japanese sawmill laborers, in time of heavy rains, now drains directly into Cedar River, but I am told that new houses for these laborers are already approaching completion and that present houses and privies will soon be torn down. So in the lumber camps and elsewhere doubtless improvement will be the order of the future, and the chief sanitary inspector that the city employs on this railroad work may, during the year of railroad building, very properly extend the scope of his inquiry and study of improved conditions throughout the watershed.

INVESTIGATIONS FOR IMPROVEMENT OF SUPPLY

47. With the best sanitary inspection that is practicable a rapidly flowing stream will always present some remote chance of danger, and therefore I am led to earnestly recommend that the city engineer make, in the immediate future, a sufficient reconnaisance both for the enlarged detention reservoir at the intake already mentioned and also for learning just what opporunity there may be of securing a supply sufficient for the present needs of the city from the remarkable series of large cool springs within two or three miles of the present intake. An inspection of the map of the watershed boundaries gives small hope that these springs will suffice for anything more than a temporary supply, but the present is a good time for reviewing all of these possibilities and for making full and precise measurements that will be very useful in all future studies.

FISHING

So long as no detention reservoir exists and the water is without filtration, fishing along Cedar River above the city's intake may well be prohibited, not on account of the fishing, but simply as one more means of lessening the chance of a man in the early and unrecognized stages of typhoid strolling along this stream. Even the spit of one coming down with typhoid is said to contain the germs of the disease, and the typhoid bacillus sometimes continues to be found in the urine for several weeks after the patient is so far convalescent as to be walking around.

SWAN LAKE AS A DETENTION RESERVOIR

A part of the chief engineer's original plans was to provide a period of detention of the Cedar River water in Swan Lake. This lake is reported to have been found containing large quantities of wild fowl guano at its upper end, and it is also stated that the elevation above sea level is somewhat smaller than desirable for economy in size of aqueduct to the higher levels of the city.

In view of the well-known possibilities of danger in taking water from a flowing stream, I venture to suggest that this whole matter of Swan Lake

and other possible sites for a detention reservoir should be carefully studied anew.

The expense already incurred by the city in securing a sparsely settled mountain watershed, and in systematically beginning to purchase the fee to the entire area as a means of excluding pollution, the excellence of this gathering ground, its sufficiency for the city for many years in the future, the great importance of a supply of water pure beyond suspicion as an asset in encouraging the city's growth, all concur to make this question of avoiding any new source of pollution paramount.

The one death per thousand inhabitants per year from water-borne typhoid may as easily be the foremost citizen as the humblest.

Respectfully submitted,

JOHN R. FREEMAN,
Consulting Hydraulic Engineer.

August, 1906.

Previous to the submission of this report Ordinance No. 13836 was passed and approved on June 6, 1906, giving the Railway Company a franchise to build.

When their report was submitted, the Council repealed Ordinance 13836, and on the 10th of December, 1906, passed Ordinance 15093, which was approved by Mayor William Hickman Moore on December 24th and accepted by the railway company on December 27th of the above year.

Following are the laws and regulations at present in force for the purpose of protecting the purity of the water supply:

SESSION LAWS OF THE STATE OF WASHINGTON, 1907

Chapter 227, H. B. 430.

WATER SUPPLY OF CITIES AND TOWNS

That Section 1 of an act (Pierce's Code, 3650) entitled "An Act to preserve from pollution the water supplied to the inhabitants of cities and towns in the State of Washington; to declare what are nuisances in the vicinity of the source of such water supply; providing for the abatement thereof, and for the punishment of the violations of this act; approved March 13, 1899," is hereby amended so as to read as follows:

Section 1. That for the purpose of protecting the water furnished to the inhabitants of towns and cities within this State from pollution, the said towns and cities are hereby given jurisdiction over all property occupied by the works, reservoirs, systems, springs, branches and pipes, by means of which, and of all the lakes, rivers, springs, streams, creeks or tributaries constituting the sources of supply from which such cities or towns, or the companies or individuals furnishing water to the inhabitants of such cities or towns obtain their supply of water, or store or conduct the same, and over all property acquired for any of the foregoing works or purposes or for the preservation and protection of the purity of the water supply, and over all property within the areas draining into the lakes, rivers, springs, streams, creeks or tributaries constituting such sources of supply whether the same, or any part thereof, be within the corporate limits of such town or city or outside thereof; and authority is hereby conferred upon such towns and cities to prescribe by ordinance what acts shall constitute offenses against the purity of such water supply and the punishment or penalties therefor, and to enforce said ordinances; and the Mayor of such town or city is hereby authorized to appoint special policemen, with such compensation as the proper authorities of said town or city may fix, who shall, after taking oath, have the powers of constables under the laws of the State, and who may arrest with or without warrant any person committing, within the territory over which such town or city is given jurisdiction by this act, any offense declared by law of this State, or by any ordinance of such town or city, against the purity of such water supply, or any violation of any rule or regulation lawfully promulgated by the State Board of Health for the protection of the purity of such water supply. Such policeman shall be, and he is hereby authorized to forthwith take any such person arrested for any such offense or violation aforesaid, before any court having jurisdiction thereof to be proceeded with according to law. Every such special policeman shall, when on duty, wear in plain view a badge or shield bearing

the words, "Special Police", and the name of the town or city for which he shall be appointed as aforesaid.

Sec. 2. An emergency exists and this act shall take effect immediately.

SESSION LAWS OF THE STATE OF WASHINGTON, 1909

Section 2. POLLUTION OF WATER. That any person who shall place or cause to be placed within any watershed from which any city or municipal corporation of any adjoining State obtains its water supply, any substance which either by itself or in connection with other matter will corrupt, pollute or impair the quality of said water supply, or the owner of any dead animal who shall knowingly leave or cause to be left the carcass or any portion thereof within any such watershed in such condition as to in any way corrupt, or pollute such water supply, shall be deemed guilty of a misdemeanor and upon conviction shall be punished by fine in any sum not exceeding five hundred dollars.

CITY ORDINANCES

ORDINANCE NO. 19061

AN ORDINANCE providing for the protection of the water supply of the City of Seattle from pollution, and providing penalties for violation of the provisions of this ordinance.

Section 1. That for the purpose of protecting the water supply of the City of Seattle from pollution, it is hereby declared to be unlawful for any person or persons to camp, picnic or loiter within the territory from which the City of Seattle derives its water supply, being the Cedar River watershed and its tributaries, including the lakes and springs in such territory.

Section 2. Any one found guilty of violation of the provisions hereof shall be fined in any sum not exceeding one hundred ($100) dollars or imprisoned in the city jail for a term not exceeding thirty (30) days, or may be both so fined and imprisoned.

Section 3. Whereas, danger from pollution of the water supply of the City of Seattle is imminent.

Approved by me this 25th day of August, 1908. Emergency.

H. C. GILL,
President City Council.

J. F. MILLER,
Mayor.

ORDINANCE NO. 27534

AN ORDINANCE amending Section 1 of Ordinance No. 19061, entitled "An Ordinance providing for the protection of the water supply of the City of Seattle from pollution, and providing penalties for violations of the provisions of this ordinance," approved August 25, 1908, for the purpose of providing additional safeguards and protection to the water supply.

Be it ordained by the City of Seattle as follows:

Section 1. That Section 1 of Ordinance No. 19061, entitled "An Ordinance providing for the protection of the water supply of the City of Seattle from pollution, and providing penalties for violations of the provisions of this ordinance," approved August 25, 1908, be and the same is hereby amended to read as follows:

Section 1. For the purpose of protecting the water supply of the City of Seattle from pollution, it is hereby declared unlawful for any person or persons to camp, picnic, loiter, trespass, fish or otherwise be within the Cedar River watershed from which the city obtains its water supply, unless they are there performing municipal work, or have been authorized to go upon said grounds or waters legally, or by permission of the Commissioner of Health, or for any person or persons, whether or not they are performing municipal work, or have been authorized to go upon said grounds or waters legally or by permission of the Commissioner of Health, as above provided, to deposit within said Cedar River Watershed any human excrement or other substances whatever deleterious to health, or to commit any act whatsoever tending to pollute the waters in said watershed.

Section 2. This Ordinance shall take effect after its passage and approval, if approved by the Mayor, otherwise it shall take effect at the time it shall become a law under the provisions of the City Charter.

Passed the City Council the 3d day of July, 1911, and signed by me in open session in authentication of its passage this 3d day of July, 1911.

MAX WARDALL,
President City Council.

GEORGE W. DILLING,
Mayor.

Published July 10, 1911.

INSTRUCTIONS TO CEDAR RIVER PATROLMEN IN THE EMPLOY OF THE DEPARTMENT OF HEALTH AND SANITATION

RAILROADS—TRAINS

It is your duty to see that all toilets on trains passing through the Cedar River watershed are locked at all times while between Landsburg and Cedar Falls, and in case of any violation it will be your duty to report the case to the conductor in charge of the train, and also report the facts to the Chief Sanitary Engineer of the department, together with the number of the car and the time and date on which such violation occurred.

ROADWAY

You will see that all protection work such as dykes, ditches and settling basins along the railroad are at all times in good repair, and any need of repairs shall be reported to the roadmaster of the division in which such repairs are needed.

You will see that train crews do not throw any refuse matter upon the tracks or roadway.

You will instruct all section gangs at work along the roadway to use sanitary facilities, as located by you in conformation with the laws regulating watersheds in the State of Washington.

BRIDGES

See that all railroad bridges hereafter built within the watershed are constructed according to standard plan furnished you by the Chief Sanitary Engineer.

You will not permit any train to discharge passengers or freight within the watershed, unless otherwise notified by the Chief Sanitary Engineer. In all cases discharge of freight within the watershed must be accompanied by a permit from the Chief Sanitary Engineer.

LOGGING CAMPS

Where permitted to operate, must at all times be maintained in a strictly sanitary manner.

TOILETS

At logging camps must be located well back from any lake, river or stream, which is a part of the Cedar River watershed, according to State laws governing such things.

All toilet vaults, when used, must be scattered well with lime, or dust, or sand, in such a manner as to exclude flies.

All toilet vaults must be burned out with fire at least one each week.

Garbage and other refuse from camps and cookhouses must be destroyed by fire, or removed from the watershed, every day.

MANURE

Manure from stables must not be allowed to accumulate at any camp within the watershed near any lake, river or stream, or at any other place, during the months of June, July, August or September, which period is commonly known as the "fly season." All manure must be removed, buried or burned at least once each week.

TOWNS AND SETTLEMENTS

Permitted to be within the watershed must be maintained in a strictly sanitary condition at all times.

See that all ditches and settling basins at the town of Taylor are at all times maintained in such a way as to protect the water supply of the City of Seattle from pollution.

It will be your duty to send a report, upon forms furnished you, showing the territory covered by you each day, to the Chief Sanitary Engineer.

ANALYSIS AND TEMPERATURE OF WATER

The following analysis of Cedar River water made by City Chemist A. Jacobson shows its purity. The temperature varies from 48 to 50 degrees from winter to summer, not enough to be noticed without using a thermometer.

	Parts Per Million
Color	None
Turbidity	None
Odor	None
Total solids	60 00
Volatile solids	14.84
Suspended matter	None
Nitrogen as Free Ammonia	.015
Nitrogen as Albuminoid Ammonia	.030
Nitrogen as Nitrates	None
Oxygen consumption	.160
Chlorine	4.00
Total hardness	13.84

A. JACOBSON,

City Chemist.

Scene Near Crest Line

Survey of Crest Line

On October 23, 1913, the final surveys were completed to determine the crest line of the Cedar River Watershed. These cover, however, only the upper watershed or that part of it which drains into Cedar Lake. The lower watershed which drains into Cedar River between Landsburg and the lake and which furnishes all the city's supply during the stage of low water in the lake except what is used by the lighting plant to turn its wheels after the lake falls below the crest of the impounding dam, has not been fully contoured up to date.

WITHDRAWAL OF LANDS IN THE CEDAR RIVER WATERSHED

Before C. R. W. S. No. 1 went into operation in January, 1901, the city made application to the Commissioner of the General Land Office at Washington for a temporary withdrawal from entry, sale, settlement or other disposal, of all lands in the watershed still owned by the United States. This was done as a means of placing the care of these lands under the jurisdiction of the city so as to guard the water from contamination. In response to this request, Hon. Binger Hermann, Commissioner, on October 10, 1899, directed the Register and Receiver of the United States Land Office at Seattle to withdraw from disposal all lands then presumed to be in the Cedar River watershed. These lands were described in the Commissioner's letter as follows:

All of Township 22 North, Range 8 East W. M. Washington; all of Township 22 North, Range 9 East, except Sections 1, 2, 3, 11 and 12; the S½ of Township 22 North, Range 10 East; the N1-3 of Township 21 North, Range 9 East, and the N½ of Township 21 North, Range 10 East.

The complete withdrawal of these lands was not consummated until February 28, 1911, when Senate Bill No. 5432 was approved by the President, withdrawing all public lands in Township 21 North, Ranges 9, 10 and 11 East, and Township 22 North, Ranges 8, 9, 10 and 11 East of the Willamette Meridian in the State of Washington where no legal filing had theretofore been made by any citizen. These townships covered all the territory in the watershed where there was any land still in

the hands of the government. The government, however, required the city to deposit a sum with the Secretary of the Interior sufficient to pay the cost of the necessary surveys to determine the crest of the watershed, the location and areas of the tracts included therein, and the appraisement of all timber on such areas. The amount thus deposited was $8,000, part of which, $5,000, was for timber cruising, and the remainder, $3,000, for crest line surveys, maps and computations.

The bill also provided that the land should be patented to the City of Seattle upon payment to the government of the value of the timber as appraised, the amount so paid, however, to be not less than the sum of money that would be realized from the sale of the whole area at $1.25 per acre. The city has not yet decided to buy the lands as the purchase is not essential if the land is properly patrolled to prevent pollution of the water supply.

TRANSFER OF SUPERVISION OF THE CEDAR RIVER WATERSHED

By vote of the electors on March 4, 1913, the superintendence of the watershed was transferred from the Building Department to the Water Department. The proceedings in connection with the acquisition of the watershed, both by purchase and condemnation, had originally been in charge of the Engineering Department, but, when Mr. R. H. Ober, who had been employed as resident engineer in the watershed, was appointed Superintendent of Buildings, he assumed the supervision of the watershed under the provisions of Section 9 of Article VIII of the City Charter, which placed the management and control of lands belonging to the city other than park and library lands in the hands of the Superintendent of Buildings.

Whether or not it was contemplated when this provision of the charter was adopted that the Superintendent of Buildings should have the custody of these watershed lands, the development of the water and lighting plants, and the manifest dependence of these public service utilities on the watershed, made it clear that the control of these lands should be transferred to one or both of these latter departments.

Since the care of the watershed was transferred to this department a trail has been opened, as nearly as possible, along the 1,700-foot contour, all around the lake. It is proposed to open another trail along the outside boundary line and connect this with the trail now made by cross trails

about two miles apart, so that any part of the territory can be reached quickly by the patrol which will be kept there for both fire and sanitary protection. The sanitary precautions are under the control and direction of the city Health Department. No fishing or hunting is allowed in the watershed, and any camps established for the purpose of getting out timber must conform in their sanitary arrangements to the requirements of that department.

SALE OF TIMBER ON SUBMERGED AREA

The new masonry dam, now in course of construction, will have a temporary height of 1,555 feet, but its final elevation will be 1,600 feet. At an elevation of 1,590 feet the water in the lake will overflow a considerable area—approximately 2,850 acres. As all the merchantable timber in this area would be lost when the water was impounded, a contract for its removal was let in March, 1913, to the Cedar Lake Logging Company at the following rates:

	Estimated Stand Ft. B. M.	Per M. Ft. B. M.
Fir	85,160,000	2.01
Spruce	5,525,800	1.25
Cedar	2,502,800	2.50
Hemlock	13,542,200	.75
Larch	1,365,500	.75
		Lin. Ft.
Piling	no estimate	.01
Cedar Poles	no estimate	.02
		Per M. Ft. B. M.
Felled timber	no estimate	.50
Felled timber along right of way		1.00
Cedar timber along right of way		1.00
Hemlock timber along right of way		1.00

All timber is to be removed by January 1, 1916.

The amount of timber covered by this contract is approximately 108,000,000 board measure. The estimated stand is shown in detail in the following table:

ESTIMATE OF TIMBER TO BE REMOVED FROM AREA TO BE SUBMERGED

Section	Township	Range	Area to be cleared Acres	FEET B. M.					
				Fir	Spruce	Cedar	Hemlock	Larch	Total
1	22	8	76	5,761,000	122,000	91,000	699,000	8,000	6,681,000
11	22	8	103	....	....	....	....	....	....
12	22	8	480	19,200,000	480,000	480,000	3,840,000	960,000	24,960,000
13	22	9	48	950,000	72,000	106,000	432,000	....	1,560,000
6	22	9	8	455,000	10,000	7,000	55,000	1,000	528,000
7	22	9	168	9,206,000	336,000	134,000	638,000	....	10,314,000
16	22	9	32	2,848,000	9,600	16,000	83,200	....	2,956,800
17	22	9	45	3,285,000	....	45,000	135,000	....	3,465,000
18	22	9	40	2,360,000	24,000	104,000	264,000	....	2,752,000
18	22	9	27	621,000	16,200	10,800	270,000	....	918,000
19	22	9	135	2,970,000	405,000	270,000	945,000	67,500	4,657,500
20	22	9	157	4,710,000	471,000	314,000	942,000	....	6,437,000
21	22	9	142	6,106,000	142,000	71,000	497,000	....	6,816,000
22	22	9	278	12,037,000	250,000	111,000	806,000	....	13,204,000
23	22	9	64	2,496,000	96,000	64,000	128,000	....	2,784,000
26	22	9	241	2,844,000	1,687,000	241,000	337,000	193,000	5,302,000
27	22	9	118	1,700,000	....	136,000	476,000	136,000	2,448,000
28	22	9	37	999,000	37,000	74,000	259,000	....	1,369,000
29	22	9	217	6,293,000	1,302,000	217,000	2,604,000	....	10,416,000
30	22	9	11	319,000	66,000	11,000	132,000	....	528,000
			2,427	85,160,000	5,525,800	2,502,800	13,542,200	1,365,500	108,096,300

New Masonry Dam Under Construction

The yield since logging began would indicate that this estimate is about one-third too high.

The percentages of the different varieties of timber to the total stand of timber on the total area from which the timber is to be removed are as follows:

Fir	78.62% of total
Spruce	5.05% of total
Cedar	2.40% of total
Hemlock	12.70% of total
Larch	1.23% of total

The amount of timber on the entire watershed is variously estimated at 500,000,000 to 800,000,000 feet board measure.

Water Power in Cedar River Watershed

The rainfall in the upper watershed, including precipitation in the form of snow, is about double the amount per unit of area that it is in the watershed between the lake and at Landsburg. The average rainfall in the upper region, which has an area of approximately 85 square miles, is 111.02 inches per year. The run-off, according to weir measurements taken at the Cedar Lake dam from 1905 to 1911, inclusive, is 386.3 cubic feet per second. When the new masonry dam is completed to a height of 1,600 feet it is proposed to raise the lake to an elevation of 1,590 feet and impound for use during the dry season about one-fourth of the total run-off during the year. Taking an elevation of 1,590, the height to which it is proposed to raise the water in the storage basin when the new masonry dam is completed, thus giving a head of 653 feet above the present wheels at the power station, and assuming a load factor of 50 per cent in the city, we have $\frac{Q\,h\,W}{33,000}$ equals 28,753 potential horse power, which, multiplied by two, gives 57,000 horse power as the load for which an installation can safely be made at Cedar Falls Station.

Water Rates and Assessments

The table on page 304 shows that water rates in this city are lower than any other city on the coast, and with a few exceptions lower than any Eastern city. The numerous reductions that have taken place in the last twenty-three years since the city acquired ownership of the plant have practically reduced the income from water receipts to the cost of maintenance, operation and fixed charges, leaving but little for new extensions. As these extensions cost from $300,000 to $400,000 per year, only a part of which is provided for by the present system of local improvement assessments, money must be provided from some source for the large trunk mains that will be necessary in the near future.

In recognition of this fact, the City Council, when making up the assessment roll for the construction of a trunk main for connecting the Ballard district with the low service reservoir at Green Lake, L. I. D. 2589, Ordinance 30243, assessed the whole cost of said main against the property benefited, the amount being $168,665.71.

Subsequently the Council cancelled all of this assessment except $29,364.52, this sum being the cost of a unit main, as theretofore designated and understood; the balance, $139,301.19, being thus left unprovided for.

The contractor, Mr. Frank McLellan, sued for the whole amount due, as the work had been completed before the Council took its final action. The Superior Court rendered judgment for the amount stricken from the assessment and ordered the Council to provide means to pay Mr. McLellan for his work.

A charter amendment was proposed, and voted on in March, 1914, providing that in future the whole cost of trunk mains shall be assessed against the property benefited.

The proposition did not carry, and at the time of the present writing, March 20, 1914, no official action has been taken to provide funds to pay Mr. McLellan for his work.

Destruction of Water Pipes by Electrolysis

The destruction of water pipes by electrolytic action on account of current leakage from the car tracks of the Puget Sound Traction, Light & Power Company constitutes a perpetual source of expense to the Departments. Bills are presented to the company regularly for the cost of these repairs, but thus far the company has refused to acknowledge any liability.

A thorough investigation into the cause of this destruction of pipes and services was made during the years 1911 and 1912, and the evidence placed in the hands of the corporation Counsel, who will probably begin action to recover. The question of liability should certainly be settled, and the attitude of the Puget Sound Traction, Light & Power Company seems to preclude any settlement except by the courts. As an example of this destructive action of the electric current on the pipes, I incorporate in this report a detailed statement of the damages.

Few people realize how rapidly an electric current will eat out a pipe. On Melrose Avenue the banding on 4,000 feet of 18-inch wood stave pipe was eaten out in seven years. The 42-inch steel pipe on Twelfth Avenue, south of Jefferson Street, was badly pitted and in some cases eaten entirely through. Along one seam lengthwise of the pipe for a distance of six feet the metal was three-fourths gone. The pipe had been in the ground only ten years. The holes in this pipe had to be plugged with rivets and some of it replaced with new pipe. The destruction is greatest, however, in the case of small service pipes. Some of these have been eaten out in three months.

Up to date the repairs that have been made necessary on mains and services on account of destruction by electrolysis amounts to nearly $10,000. Of course, this does not take into account the constant disintegration of the pipe which is going on, and which reveals itself only when the pipe fails to convey water and breaks out into leaks. It is hoped that the Legal Department of the city will be able to secure an equitable adjustment of this matter in the near future.

REPORT ON ELECTROLYSIS

Seattle, March 28, 1914.

Mr. L. B. Youngs,
Superintendent of Water,
Seattle.

Dear Sir:

The following report is the result of investigations by the Lighting Department covering a period of nearly a year to determine the extent and nature of damage done to the mains of the Water Department by electrolysis. For the past twelve or fourteen years it has been necessary to renew service pipes in various parts of the city after only a few years of use. Examination of the damaged pipes showed that they had been weakened by electrolysis. During the past three years the same sort of damage has occurred to larger mains, and the expense of repairs and replacing of corroded pipe has increased rapidly. Accordingly it seemed advisable to undertake a thorough survey of the mains of the Water Department, especially those iron and steel pipes in the districts where the most damage had occurred. It is the result of this survey that is embodied in this report.

In every case where damage to services or mains have been noted by the Water Department during the past year, careful notes have been taken as to the amount of damage, and, wherever possible, photographs have been secured showing the condition of the injured pipe. Enough measurements of the voltage and current flowing in the pipes have been taken to show beyond doubt that electrolysis is the cause of the corrosion. A detailed account of the instances of damage would require too much space for a report of this kind. A few typical examples will serve to show the nature of the injury and give an idea of the extent of the damage throughout the city. On East Jefferson Street, in one district four blocks long, it has been found that the ordinary galvanized service pipe lasts only from four to six months. One service in that district was repaired August 7, 1909, again March 30, 1910, again July 3, 1910, and again October 17, 1911, and in each case the pipe was corroded at about the same point. This is but one of many similar instances which show the damage done to service pipes by electrolysis. In 1912 excavation was made on the 12-inch cast iron main running along Broadway. The pipe was uncovered for eight feet and the soil removed all around the pipe. The main was found to be pitted and softened, so that pieces half an inch thick could be scraped off with the finger nail. This main is five-eighths inches thick and as it was carrying water at the time, no extensive cutting to determine the depth of the corrosion was done. It is, however, only a question of time when the corrosion must weaken the pipe to the breaking point.

In another district in North Seattle, service pipes have given trouble for several years, and one four-inch service pipe has been renewed several

times. Here, as in the other districts, the heaviest damage appears near the joints between the meter and the service main. Another district that gives promise of considerable trouble is the West Seattle district near California Avenue and West Alaska Street. A 12-inch cast iron main that has been in service only about two years, has already been repaired several times. Here, as elsewhere, measurement by volt meter clearly indicates the presence of heavy electric currents. The accompanying photograph shows strikingly the effect of electrolysis on a piece of cast iron pipe, which was taken from the main mentioned above. The pipe was eaten through in several places and at one place the iron was so softened that several 20-penny spikes were easily driven through the pipe. In all, about 40 feet of the main was removed and it is probable that further repairs will be necessary at the same point very soon.

The same damage from electrolysis has appeared in Fremont, in Ballard, along the waterfront from Cherry Street to Pine Street, and in various other districts of the city. Observations on the 12-inch Kalamein pipe running between the Volunteer Park reservoir and the Queen Anne standpipe indicate the danger that this pipe will also be corroded at several points. This main is a seamless steel pipe 12 inches in diameter, coated with pure tin inside and out, and joined together with expansion lead joints. On account of its seamless construction and tin coating, it is an admirable conductor, and so is especially liable to electrolysis.

In August, 1911, when the 42-inch steel main carrying the main supply of water from Cedar River was repaired, it was found badly pitted for a distance of two blocks on Twelfth Avenue near Jefferson Street. In about 300 places the main was so nearly eaten through that it was necessary to drill and plug with rivets. The pipe was then painted and covered. Several months later the pipe was uncovered near Twelfth Avenue South and Jackson Street in order to lower it on account of the regrade in that district. Just before making the final connection it was noticed that a heavy spark was obtained by connecting the two ends with a crow-bar. After the main was connected together and water turned in, a leak was noted near Twelfth Avenue and Jefferson Street. Upon excavation the main was found eaten entirely through in several places, and along one seam for a distance of six feet, the metal was three-fourths gone. The heads of the rivets that had been inserted were eaten off and the pipe was in bad condition for a considerable distance. Temporary repairs were made by plugging the holes with wooden plugs, and a few weeks later about one hundred feet of the main was removed and new pipe put in its place. While the condition of the pipe and the presence of black iron oxide at the point of corrosion showed that the injury was due to electrolysis, sufficient electrical measurements were taken to prove beyond question the presence of stray current in the pipe.

An estimate of the expense that would be necessary to replace mains and services damaged by electrolysis has been made, using contractors'

prices as a basis of costs. This estimate, while not complete, covers the greater part of the cost of replacement of such mains.

COST TO REPLACE MAINS AND SERVICES

BROADWAY DISTRICT			
7,055 ft. 12 in. cast iron main	@	$2.50	$ 17,635.50
7,000 yds. pavement	@	3.00	21,000.00
173 services	@	30.00	5,190.00
FREMONT DISTRICT			
2,546 ft. 6 in. wood pipe	@	.60	1,527.60
1,245 ft. 8 in. wood pipe	@	.75	933.75
76 services	@	10.00	760.00
NORTH SEATTLE DISTRICT			
1,709 ft. 8 in. cast iron main	@	1.45	2,478.05
1,235 ft. 6 in cast iron main	@	1.20	1,482.00
52 services	@	10.00	520.00
WEST SEATTLE DISTRICT			
5,000 ft. 12 in. cast iron main	@	2.50	12,500.00
13 services	@	15.00	195.00
BALLARD DISTRICT			
1,518 ft. 8 in. cast iron pipe	@	1.45	2,201.10
2,200 ft. 6 in. cast iron pipe	@	1.20	2,640.00
50 services	@	30.00	1,500.00
2,500 yds. paving	@	3.00	7,500.00
2,948 ft. 42 in. steel main	@	20.00	58,960.00
Total			$137,022.50

The above figures, approximately one hundred forty thousand dollars, represent the cost to replace the pipe in the above districts only and does not take into consideration losses from flooding nor fire hazard, incident to broken mains. At least one instance of loss from fire on account of broken mains has been noted. During the repairs to the 12-inch main in West Seattle, mentioned above, a residence on the hill caught fire and since there was no water, was completely destroyed.

SUMMARY

From the above facts we draw the following conclusions concerning the injury done by electrolysis to the mains of the Seattle City Water System.

First: For a considerable period of time, in various districts of the city, it has been necessary to renew service pipes after only a few months' use on account of corrosion due to electrolysis.

Second: Lately this damage has extended to the larger mains, and the expense necessary for repairs has increased rapidly.

A Section of Wooden Pipe Line

Third: Electrical measurements have been taken which prove that the current which causes the damage comes from the railway substations of the Puget Sound Traction, Light & Power Company.

Fourth: Unless some way of remedying the conditions is found, it is only a question of time when it will be necessary to renew a great many sections of expensive cast iron water mains.

Respectfully submitted,

J. D. ROSS,

Superintendent of Lighting.

COST OF WOOD STAVE PIPE IN PLACE

Cost of 42 in. and 54 in. wood stave pipe with lumber at $31.25 per 1,000 feet B. M. in place, steel bands at 4½ cents per pound in place and common labor at $2.00 to $2.25 per day.

Cost of 42 in. pressure pipe in place per lineal foot with 3-5/8 in. bands per foot.

27 ft. B. M. of fir staves @ $31.25 per M.	$0.84375
3-5/8 in. bands 40½ lbs. @ 4½c.	1.8225
3 Mal. Allen shoes, 5.64 lbs. @ $0.0515	.29
48 cu. ft. ex. back fill per lin. ft. @ 31c. per yd.	.551
Total	$3.507

Cost of 54 in. pressure pipe in place per lin. ft. with 3-5/8 in. bands per foot.

33 ft. B. M. fir staves @ $31.25 per M.	$1.03
3-5/8 in. bands 52½ lbs.	2.36
3 Mal. Allen shoes, 5.64 lbs. @ $0.0515	.29
63 cu. ft. excavation @ $0.31 cu. yd.	.723
Total	$4.403

42 in.—25	ft. B. M. per ft.	25 to 27 staves
44 in.—26	ft. B. M. per ft.	26 staves
54 in.—33	ft. B. M. per ft.	33 staves
*51½ in.—40	ft. B. M. per ft.	32 staves
60 in.—46¼	ft. B. M. per ft.	37 staves
48 in.—30	ft. B. M. per ft.	30 staves

* The staves for this 51½ in. pipe are thicker than for the other sizes.

COST OF RENEWING STAVES FOR 1,600 LINEAL FEET OF 44-INCH STAVE PIPE AT PETERSON'S LAKE IN JUNE, 1913

Common Labor, $2.75 per day

Labor	Amount	Cost	Cost per Lineal Foot	Total
Excavation:				
130 days' labor..................	$357.50			
28¼ days' team..................	141.25	$498.75	.311,718	
Tamping Pipe:				
78 days' labor..................	214.50			
26 days' team..................	130.00	344.50	.215,312	
Painting Lumber:				
17 days' labor..................	46.75	46.75	.029,218	
Cinching Pipe:				
58 days' labor..................	159.50	159.50	.099,687	
Wrecking Pipe:				
30 days' labor..................	82.50	82.50	.051,562	
Erecting Pipe:				
72 days' labor..................	198.00	198.00	.123,750	.831,247
Total cost of labor 1600 feet pipe....	$1330.00			
Total cost of labor 1 foot pipe.......	.831,247			
Material:				
42551 feet stave lumber @ $31.25 per M	$1329.72	$1329.72	.831,075	
Hauling Lumber:				
6 days' labor..................	16.50			
13¾ days' team..................	68.75	85.25	.053,281	
155 gallons C. A. Wood Preserver—65c	100.75	100.75	.062,968	.947,324
Total cost of material 1600 feet pipe. (Exclusive of iron bands and shoes.)	$1515.72			
Total cost of material per lineal foot of pipe..... .947,324				
Total cost of labor........ .831,247				
$1.778,571				

COMPARATIVE COST OF MAINTAINING STEEL RIVETED AND WOOD STAVE PRESSURE PIPE

The pipe line for Cedar River Water Supply No. 1 has now been installed thirteen years. The decay of these staves renders this line very unreliable as a supply pipe, and the reconstruction of the wooden staves during the next two or three years has become a necessity. As the iron bands are still in good condition for use, and from all indications will be good for another use after the second set of wooden staves are decayed, I have estimated a period of 45 years as the probable life of these bands. It appears that fifteen years is the life period of the wood staves. There would thus be one original installation, and two renewals of the staves before the line as a whole would be worn out. The cost of the original excavation for the line would naturally be greater than the cost of excavation for its renewal. There would be no stumps or roots to remove, no earth fills would be necessary, and the space occupied by a 42-inch pipe would reduce the quantity of dirt to be removed by 2,255 cubic yards per mile; but the advance in laborers' wages by ordinance, together with the advance in the price of stave lumber since the original installation, would probably make the cost of the second installation equal to if not more than the first. I have taken the actual cost of rebuilding 1,600 feet of pipe in the summer of 1913 as a basis for computing the whole cost of renewal of the staves, showing $211,294.23 as the probable cost of renewing the entire wooden part of the pipe. The staves for the original installation cost $31.25 per 1,000 feet in place. The staves for the renewal of 1,600 feet in 1913 cost $33.25 delivered at ditch. Adding to this latter the cost of wrecking old pipe, and erecting, cinching and painting the new, would bring the cost of staves in place up to $1.07 per running foot, exclusive of bands, excavation and backfilling, as against 81¼ cents on the original installation.

COST OF INSTALLING AND RENEWING 42-INCH STEEL AND WOODEN PIPE

Estimated life of steel pipe	45 years
Estimated life of wooden staves	15 years

The steel riveted pipe originally installed varied in thickness from ¼-inch to 7/16-inch, but as the ¼-inch is heavy enough for any pressure that the wooden staves will stand, I have taken the cost of this latter thickness in estimating on the steel pipe to replace the wood.

The cost would then be as follows:

With common labor at $1.75 to $2.00 per day.	
Excavating and backfilling for 22½ miles of ¼ in. steel pipe (same as wood)	$ 73,170.00
Cost of 22½ miles of ¼ in. steel riveted pipe in place	961,092.00
Total cost	$1,034,262.00
Interest at 5% on $1,034,262 for 45 years	2,327,089.50
Total cost steel pipe	$3,361,351.50

WOODEN PIPE

COST OF ORIGINAL INSTALLATION:

Excavating and backfilling for 22½ miles of pipe	$ 73,170.00
Wood staves and labor of cinching	101,725.34
Cost of bands in place	148,056.87
	$322,952.21
Cost of first rebuilding:	
Excavating and wrecking old pipe	$ 43,157.66
Erecting, cinching, painting and tamping	55,594.48
Stave lumber @ $33.25 per M. on ground	105,061.49
Paint	7,480.60
	$211,294.23
Cost of second rebuilding (same as first)	211,294.23
Interest at 5% for 45 years on $322,952.21	$ 726,642.47
Interest at 5% for 30 years on 211,294.23	316,941.34
Interest at 5% for 15 years on 211,294.23	158,470.67
Total interest charge	1,202,054.48
Original cost plus two renewals	745,540.67
Total cost	$1,947,595.15
Total cost steel riveted pipe	3,361,351.50
Difference in favor of wooden pipe	$1,413,756.35

LENGTH, SIZES, UNIT PRICES AND COST OF WATER MAINS ON L. I. Ds. FROM JANUARY 1, 1901, TO DECEMBER 1, 1913

	Total Feet	Unit Price	Total Amount
Cast Iron Pipe:			
30″	5,719.77	11.03	63,089.50
24″	22,430.51	7.1398	160,149.88
20″	61,711.3	5.8665	362,029.61
16″	28,855.13	4.88	140,831.57
12″	198,056.48	3.016	597,326.88
10″	40,482.8	2.514	101,766.59
8″	1,036,431.01	1.7669	1,831,246.69
6″	77,822.52	1.548	120,495.88
4″	13,049.8	.988	12,893.91
30″ (Laying only)	3,532.83	4.056	14,331.15
24″ (Laying only)	709.1	8.40	5,956.44
4″ (Laying only)	116.	1.25	145.00
			3,410,263.10
Wooden Pipe:			
20″	23,730.1	3.30	78,301.79
18″	16,774.	2.01	33,715.74
16″	42,901.8	1.833	78,649.54
12″	21,161.	2.205	46,653.58
10″	23,566.4	1.436	33,854.18
8″	247,796.3	1.192	295,267.42
6″	80,507.6	.8815	70,969.25
4″	714.9	.69	493.28
			637,904.78
Steel Pipe:			
42″	4,595.44	12.3945	56,958.64
36″	2,108.13	11.1026	23,405.76
32″	4,051.5	7.94	32,168.91
30″	75.05	10.60	795.53
24″	2,887.	7.45	21,508.15
			134,836.99
Lock Bar Steel Pipe, 36″	1,354.83	12.848	17,406.86
Gal. Lap Welded Steel Pipe, 10″	1,613.92	7.243	11,689.71
			29,096.57
Kalamein Pipe, 12″	19,192.25	2.909	55,836.96
Kalamein Pipe, 4″	3,723.1	.63	2,345.55
			58,182.51
Galvanized Iron Pipe, 2″	21,972.7	.4008	8,808.84
Wrought Iron Pipe, 2″	607.	.342	207.34
			9,016.18
Additional Hydrants	652. @	129.70	84,565.27
Hydrant Extensions	....	....	1,652.35
Gate Chambers	653. @	39.10	25,536.00
Water Connections	....	....	1,697.35
Special Castings	....	....	2,146.23
Incidentals	....	....	1,332.95
Total, $4,396,230.28			116,930.15

COST OF INSTALLING WATER TAPS

Tap No.	Size	Cost of Material and Time
30852	½	$ 9.29
30891	½	10.32
30856	½	8.65
30857	½	6.62
30841	½	6.32
30840	½	6.67
30826	½	8.89
30823	½	5.99
30819	½	8.45
30816	½	11.15
		82.35
Average Cost		8.235
30880	¾	9.93
30865	¾	9.32
30862	¾	10.38
30886	¾	9.30
30845	¾	9.75
30899	¾	9.00
30842	¾	12.52
30894	¾	12.58
30858	¾	8.73
30846	¾	13.23
		104.74
Average Cost		10.474
30366	1	11.07
30090	1	11.92
30392	1	10.94
30318	1	13.66
30162	1	10.10
30319	1	12.28
30707	1	14.30
30767	1	10.33
30850	1	12.25
30344	1	21.99
		128.84
Average Cost		12.884

As the fee charged for installing services is $8 for a half inch, $10 for a three-quarter inch, and $12 for a one inch, it will be seen that the department incurs a small loss in doing the work at present rates of wages.

COST OF WATER SUPPLIED BY GRAVITY IN THE YEAR 1913

Operation	$136,222.28
Maintenance	61,848.24
Reconstruction	20,737.55
Interest on bonds	244,820.70
Depreciation	195,115.34
	$658,744.11

Capacity of Cedar River Pipe Lines:

Pipe Line No. 1	22,000,000 per day
Pipe Line No. 2	45,000,000 per day
Total	67,000,000 per day

$658,744.11 ÷ 365 = $1,804.78 per day
$1,804.78 ÷ 67 = $26.94 per million gallons
$26.94 × 7½ = $202,027 per million cubic feet
$202.027 per million cu. ft. = $0.0202 per 100 cu. ft.

This cost is based on the supposition that we have a market for 67 million gallons per day. As a matter of fact we have a market for not more than 25 million gallons per day. Therefore the real cost of water actually sold is 67/25 × .0202 = $.0541 per 100 cubic feet.

RATIO OF PREMISES SUPPLIED TO POPULATION

On January 1, 1913, there were in active use 38,500 water taps. Of these 31,900 were metered leaving 6,600 services on fixed rates. On the metered services 5,000 supplied more than one premises; the average so supplied being three premises to a service. Fifteen thousand premises were therefor supplied by these 5,000 meters, leaving 26,900 premises which were supplied by one meter to each premises. The result is as follows:

No. of premises supplied individually	26,900
No. of premises supplied jointly	15,000
No. of premises supplied on fixed rate	6,600
Total premises supplied	48,500

The best authorities give six persons to each house supplied as the ratio for cities of two to five hundred thousand people. Applying this ratio we have 291,000 as the probable population taking city water on January 1, 1913. The number of premises that do not take city water is not great, probably not more than two thousand in the whole city. If we add 8,000 people to the above we shall have 299,000 as the total estimated population of the city.

Theories for Fixing Water Rates

Many people think that there should be a basic or initial sum in each bill for water, varying according to the size of the service installed for each premises. They base this opinion upon the theory that each service is presumed to draw upon the water supply, and upon the whole equipment necessary to furnish the supply, in proportion to its size, a 4-inch service, therefore, drawing four times as much as a 2-inch, a 1-inch four times as much as a ½-inch, and so on. It is claimed that consumers having large services may use through those services very little water—often less than those having small services—but the part of the general equipment necessary to meet the requirements of the large service, must be kept ready at all times to supply that service, whether water is being used or or not, and for this reason, a basic charge should always be collected regardless of the water actually consumed. I submit a computation to show how this plan would work out in practice.

Reducing the cross sectional area of each size of pipe to its equivalent in unit areas of a ½-inch pipe we find them to be as follows:

¾ in.	2¼	units of area
1 in.	4	units of area
1½ in.	9	units of area
2 in.	16	units of area
3 in.	36	units of area
4 in.	64	units of area
6 in.	144	units of area
8 in.	256	units of area

The basic charge, therefore, for each size of pipe, regardless of the quantity of water delivered through such pipe, should be in the ratio of the above numbers. The rapid increase thus shown in the liability is clearly due to the increase of ratios between the square of the diameters of different sizes of pipe, because the capacity to deliver increases as the squares of their diameters, and the basic charge, under this theory, should increase accordingly.

If we assume a minimum rate of 50 cents for a ½-inch pipe it is clear that the minimum for the larger sizes would run very high, if the above ratio were applied in making the charge; a 2-inch pipe being sixteen times greater than a ½-inch pipe. While this theory of fixed charges has some points of merit, it would seem to be less scientific and just than a method of charging either by land areas benefited or by volume of water supplied.

Of course, under this system there would have to be added to the basic charge an additional charge for the water actually delivered through each pipe, as the basic charge is intended to cover only what is known as the overhead or general charges for the general equipment, apart from the charge for operating and maintenance, taps and meters. These latter expenses would have to be met by a direct charge for water delivered, the two rates together making the total charge.

Another school of thinkers believe that the cost of the general equipment of a city water plant—the headworks, pipe lines, and reservoirs—should be charged up in taxation against all the property in the city, because, unlike the local distributing mains, they are installed for the purpose of supplying all property in the city, and are available for use by all property whenever and wherever the owners of property on any street see fit to put in a distributing main and avail themselves of the general equipment. Large trunk or feed mains, according to this theory, should be charged against the property of the particular district which they supply; while small mains, intended to supply only such property as abuts upon the street where such mains are laid, should be assessed in full against such abutting property. The water tap and meter should be paid for by each piece of property at the time such property is connected to the abutting main. It is held that this would distribute the cost of construction in accordance with the benefits received. This theory assumes that vacant property, not using water, but for which the water is just as available as it is for any contiguous improved property should pay as much of the general construction cost as improved property, but that the improved property should pay such additional sum as is represented by the cost of operating the plant over and above the cost of construction. The operating expenses, both labor and material, should, therefore, be charged up against the consumer, but not against the holder of vacant property who is a non-consumer. He should pay only his share of the construction costs, because he does not need to have the plant operated until he becomes a consumer. It may be argued that, by the same token, he does not need to have the plant constructed until he becomes a water consumer; but, note, here a plain distinction. While the mere operation of the plant does not benefit him until he begins to take water, the construction of the plant does benefit him, by making his property available both for use and sale, and giving it a value which, otherwise, it would not have. Having thus received an important benefit, it is held that he

TEMPORARY DAM AT CEDAR LAKE

HEADWORKS AT LANDSBURG

should pay for that benefit just as the man who uses water pays for a like benefit.

If such a system of charges were adopted it would work out approximately as follows:

Taking the 56½ square miles of land area within the city limits, and deducting 35 per cent of it for street areas we have left an area equal to 256,000 lots each 40 feet by 100 feet. A tax of one dollar per annum on each of these lots would produce revenue enough to pay the interest on the present bonded and warrant indebtedness of the water plant. This would be a charge of 8 1-3 cents per month on each lot of 4,000 square feet area, as against a 50 cent minimum charge for water on each improved premises.

A levy of $2.00 per year per lot or 16 2-3 cents per month, just one-third of the minimum monthly rate for an improved premises, would produce revenue enough to pay the interest and five per cent of the principal of the present debt each year, which would liquidate the bond issue in 20 years.

It is evident that under this plan the present water rates could be reduced 50 per cent, as only half the necessary revenue would then have to be raised from water charges. The question resolves itself into what is a fair arrangement between water consumers and all property holders that are benefitted by the installation of the water plant.

THE SPECIAL FOUR CENT RATE

Ordinance No. 4443, approved March 8, 1897, established a rate of 4 cents for 100 cubic feet for all water used by motors, elevators and factories in excess of 30,000 cubic feet per month. By the provisions of Ordinance No. 16474, approved July 8, 1907, laundries were included in this 4 cent rate.

The reasons for such a discrimination in favor of certain classes of business are not very clear. The theory that manufacturing would be stimulated by a difference of 2 cents per 100 cubic feet in the cost of water used in factories seems very inadequate. At any rate I see no occasion for perpetuating this form of discrimination unless some more solid reason can be shown for it than has yet been presented.

The effect of this policy is shown in the following computation:

No. of meters allowed a 4c. rate for all quantities in excess of 30,000 cu. ft. per month, but which did not in any case run above that amount	72
Total No. of meters entitled to the manufacturer's rate	188
Total quantity of water passed through 116 meters in excess of 30,000 ft during the last half of the year 1910, cu. ft.	53,425,609
Twice this quantity would be 106,851,218 cu. ft. used in one year.	
This amount at 4c. per 100 cu. ft. would bring in	$42,740.52
This amount at 6c. per 100 cu. ft. would bring in	64,110.76
The difference shows the amount sacrificed to these 116 favored consumers on account of the reduced rate	$21,370.24

For the year 1913 the effect would be as follows:

Income received from 86 meters during first half of 1913, for all water sold at manufacturer's rates. (4c. per 100 cu. ft.)	
Total amount used 57,236,300 cu. ft. @ .04	$22,894.52

NOTE.—The amount used for the last 6 months of 1913 will be somewhat higher, but in no case will the total amount for the year exceed $50,000. This would equal 125,000,000 cu. ft., and if the rate of 6c. per 100 cu. ft. were charged instead of 4c., the increase in revenue to the city from that source would be $25,000.

THE FIFTY CENT MINIMUM RATE

Ordinance No. 31075, approved April 2, 1913, provides that a minimum rate of 50 cents per month be charged on each premises supplied by meter, whether such premises be a single house or only one of a number which are supplied through the same meter. There has been considerable dissatisfaction with this arrangement, principally, I think, because people generally do not understand the reasons upon which it is based. The meter rates are very low, and where several houses are connected on a single metered service it is found that the charge per house will frequently fall as low as 10 or 15 cents per month. Such a charge pays but little more than the cost of meter reading and office work in billing and collecting. It does not provide anything for the cost of installation of plant and operating expenses. In other words, it throws these expenses upon the men who pay a minimum rate on a single property. This is an unjust discrimination, and encourages the practice of keeping many houses on a single service, while the man who installs a service for his own use, not only pays eight or ten dollars for the installation, but carries most of the water bill for the man who is connected on some other person's service. It is because people have not reasoned out the elements of the case as

above that many are dissatisfied, but when the full facts are shown it becomes manifest that the rule is altogether just.

Number of metered water consumers classified according to amounts paid for water (October, 1913):

A.	$0.50	16,771
B.	.55 to $ 0.75	6,048
C.	.80 " 1.00	4,131
D.	1.05 " 2.00	3,763
E.	2.05 " 5.00	1,750
F.	5.05 " 10.00	676
G.	10.05 " 25.00	497
H.	25.05 " 50.00	157
I.	50.05 " 100.00	94
J.	Over 100.00	60
	Grand Total	33,947

Rules and Regulations

Inquiries come to the office almost daily for information with reference to the charges made for water in this city and rules and regulations under which it is supplied.

Ordinance No. 31075, approved April 2, 1913, prescribes these rules and regulations and fixes the rates that shall be charged.

Its provisions are as follows:

ORDINANCE NO. 31075

An Ordinance Relating to the Municipal Water Supply System of the City of Seattle, regulating the use of water therefrom, providing for the sale of same, fixing the price thereof and providing a method of collecting rates therefor, providing penalties for violations of this ordinance and repealing all ordinances or parts thereof in conflict herewith.

Be it ordained by the City of Seattle as follows:

Section 1. The word "Superintendent," wherever used in this Ordinance, shall be held and construed to mean the Superintendent of Water Works of the City of Seattle, and any act in this ordinance required or authorized to be done by the Superintendent, may be done on behalf of the Superintendent by an authorized officer or employe of the Water Department. The word "person," wherever used in this ordinance shall be held to mean and include natural persons of either sex, associations, copartnerships and corporations, whether acting by themselves or by a serv-

ant, agent or employe; the singular number shall be held and construed to include the plural and the masculine pronoun to include the feminine.

Section 2. Any person desiring to have premises connected with the water supply system of the City of Seattle, shall present at the office of the Water Department a copy of building permit or a regular certified copy from the Superintendent of Buildings, containing his name, description of lot, block and addition and the official house number of the premises on which water is desired, and shall make application therefor upon a printed form to be furnished for that purpose, which application shall contain the description of the premises where such water is desired and shall state fully all of the purposes for which the water is to be used, the number of families to be supplied, and the number of sinks, hose bibs, water closets, baths, laundry trays, basins and faucets on said premises and to be connected with the water supply, the size of service pipe and whether service shall be by meter or at fixed rates, and shall be signed by the owner of the premises to be served, or his duly authorized agent, and shall be filed in the office of the Superintendent, and at the time of filing such application the applicant shall pay to the City Treasurer and take his receipt therefor, the fees for installation of water service hereinafter provided.

Section 3. The application provided for in the preceding section shall contain a contract on the part of the person making the same, to pay for the water applied for at the rate and in the manner specified in such contract, and shall reserve to the City of Seattle the right to charge and collect the rates and enforce the penalties provided for in this ordinance, in the manner herein provided, to change the rates at any time by ordinance, to temporarily discontinue the service at any time without notice to the consumer and to install a meter or meters to register the water consumed, and shall specify that said contract is subject to all the provisions of this ordinance and of any ordinance of the City of Seattle relating to the subject, hereafter passed, and shall provide that the City of Seattle shall not be held responsible for any damage by water or other cause resulting from defective plumbing or appliances on the premises supplied with water, installed by the owner or occupant of said premises, and that the fact that the agents of the city have inspected the plumbing and appliances shall not be pleaded as a basis of recovery in case of damage to premises from defective plumbing or appliances installed by the owner or occupant of such premises, and shall provide that in case the supply of water shall be interrupted or fail by reason of accident or any other cause whatsoever, the city shall not be liable for damages for such interruption or failure, nor shall such failures or interruptions for any reasonable period of time be held to constitute a breach of contract on the part of the city or in any way relieve the consumer from performing the obligations of his contract.

Section 4. All contracts shall take effect from the day they are signed and rates shall be charged from the day the premises are connected with the city's water supply and the water turned on.

Section 5. Upon the presentation at the office of the Superintendent, of the Treasurer's receipt for the installation fees and the execution of the contract hereinbefore provided for, the Superintendent shall cause the premises described in the application, if the same abut upon a street upon which there is a city water main, to be connected with the city's water main by a service pipe extending at right angles from the main to the property line including a stopcock placed within the lines of the street curb, which connection shall thereafter be maintained by and kept within the exclusive control of the city. In case of application for water service on premises not abutting upon a street upon which there is a city water main, the city will lay its connection from the main toward the premises for a distance equal to the distance from the main to the curb line, said distance in no case to exceed 40 feet, and permit connection therewith by means of a union and pipes laid at the expense and maintained by the owner of the service, or may in the discretion of the Superintendent, upon the payment of the actual cost thereof, extend the service to the premises of the applicant along and beneath any public street or avenue of the City of Seattle, but not otherwise. No premises shall be allowed to have more than one service connection and no service connection will be allowed from the city mains to any premises supplied by water from any other source unless special permission is given by the Superintendent, which special permission may be terminated at any time the Superintendent may elect.

Where there is a water main in front of any premises every house supplied by city water must install its own separate service connection with the city main, and the premises so supplied will not be allowed to supply water to any other premises, except temporarily where there are no mains in the street; provided that such restrictions shall not apply to services already installed unless in the judgment of the Superintendent, for the good of the service or to settle disputes, it is found necessary to enforce such provisions as to connections already made. Provided, further, where two or more buildings are supplied by one service through a meter not less than the minimum rate for premises supplied by meter hereinafter provided for, shall be assessed for each separate building or premises so supplied.

Section 6. All persons connecting to city services, or laying their own private pipe shall be required to use only standard galvanized iron pipe up to and including two inches in size, and all pipes shall be laid not less than two feet below the surface of the ground, except that in ungraded streets where the grade is already established, said services and pipes shall be laid at least two feet below said established grade. The Superintendent will maintain private services from the city mains in streets which are being graded or regraded and will have such access on private property as shall be necessary to maintain such pipes during the work, and shall as soon as practicable upon the completion of such work, relay said pipes in street. Except for above cause owners shall maintain their private pipes from the end of the city service to and into their property, or in case the Superin-

tendent finds it necessary to maintain same the owner shall relinquish all rights to said pipes. When necessary the Superintendent may slope services in on property to conform to the slope occasioned by the grade of street and charge expense to owner of service.

Section 7. The fees for the installation of water service as hereinbefore provided shall be as follows:

For a one-half (½) inch connection	$ 8.00
For a three-fourths (¾) inch connection	10.00
For a one (1) inch connection	12.00

For sizes larger than one (1) inch, or where it becomes necessary to open a paved street, the actual cost of labor and material in laying such a service and replacing the pavement shall be charged. In such cases, and in cases of connections extending along a street on which there is no main, the cost of material and labor shall be estimated by the Superintendent and the estimated cost shall be paid to the City Treasurer by the person applying for such installation before the work of connecting the main with the property is begun; provided, that whenever the estimated cost is not sufficient to cover the total expense for labor and material the deficit shall be charged to the property for which such installation was made and to the owner thereof; and provided further, that any excess payment shall be returned to the person applying for the installation. No service larger than three-fourths (¾) of an inch shall be installed where a meter is not to be used.

Section 8. Before water will be turned on to any premises connected with the city's mains, the service pipes upon such premises must be made to conform to the following regulations: The service pipes must be so located that the supply for each separate house or premises shall be controlled by separate stop and waste cocks of the best standard make, approved by the Superintendent, with extension handle, properly protected from the frost, and so placed within the premises that all service pipes and fixtures may be thoroughly drained during the freezing weather. Where sags or depressions occur in the pipe and this stop and waste cock is not sufficient to fully drain all the pipes and fixtures within the premises, additional stop and waste cocks, with extension handles, or other approved vents must be so placed as to fully drain them. In cases where no fixtures are placed between the property line and the basement, the stop and waste cock may be placed in the basement, provided said basement is not less than six (6) feet in height and is provided with stairways or other means of access thereto; provided further, that where basements are enclosed in wooden walls the stop and waste cock shall be placed at least twelve (12) inches below the surface of the ground, and shall be provided with an extension handle. Stop and waste cocks on premises fronting on ungraded streets shall be placed at least six (6) feet inside of property line of said premises. The connection between the city's pipes at the property line and the service pipes on the premises must be made with

a union. Every existing service or branch service not already equipped as required in this section must be so equipped at the owner's expense as soon as the defect is noted.

Section 9. Whenever the owner or occupant of any premises connected with the city's water supply system shall desire to use the water he shall notify the Superintendent and request that the water be turned on to the said premises. The owner shall leave his portion of the service exposed in the trench until the water is turned on by the Superintendent, when he shall immediately properly cover the pipe.

Section 10. It shall be unlawful for any person whose premises are supplied with water, either at fixed rate or through meter, to install additional fixtures on said premises or to apply the water to purposes other than those for which the original application was made or to furnish water to additional families or premises, or fixtures unless he shall first make application in writing so to do upon a printed form furnished for that purpose, and in the same manner as an original application for the installation of water service.

Section 11. When additional fixtures or premises are connected without the application prescribed in the preceeding section, such fixtures or premises may be charged at double the rate for the time they are in use, and the service may be shut off by the Superintendent and a charge of two dollars ($2.00) made for shutting off and turning on such service. In case water shall be turned off as provided in this section, the same shall not be turned on again until all rates and charges against such premises have been paid in full.

Section 12. When new buildings are to be erected on the site of the old ones and it is desired to increase the size or change the location of the old service connection, or where a service connection to any premises is abandoned or no longer used, the Superintendent may cut out or remove such service connection, after which, should a service connection be required to said premises, a new service shall be placed only upon the owner making an application and paying for a new tap in the regular manner. When the service connection of any premises on an unpaved street does not exceed one (1) inch in size and the same does not come from the main in front of said premises the Superintendent shall, when a main is laid in front of said premises, after notifying the owner or tenant thereof, transfer the service connection to the new main without charge, and at the same time cut out the old service connection. When a new main is laid in any street, owners of premises on said street, or within one-half block on side streets, who are being supplied with city water from a private main or a connection to a private service shall make application for tap and shall connect up with a separate service connection to the main in front of premises.

Section 13. Whenever the owner or occupant of any premises connected with the city's water supply system desires to discontinue the use of

water for any special purpose or through any fixtures mentioned in the original application, he shall cause such fixtures to be removed and the branch pipe of service supplying the same to be plugged, and shall notify the Superintendent in writing before any reduction of rates will be made.

Section 14. It shall be unlawful for any owner of any premises connected with the city's water supply system to disconnect the water on said premises unless he shall first file in the office of the Superintendent, on a printed form to be furnished for that purpose, a written request that the service of water to said premises be discontinued, and shall pay all arrearages on water rates for said premises, together with a charge of One Dollar ($1.00) for shutting off the water. When water has ben shut off from any premises upon the application of the owner thereof, or for non-payment of water charges, or for any other cause, it shall be unlawful for any person again to connect such premises with water except when authorized so to do by the Superintendent.

Section 15. When water has been shut off for any cause, and is turned on again or allowed or caused to be turned on by the owner, no remission of rates will be made on account of its having been shut off, and the Superintendent may then shut off the water at the main, or remove a portion of the service connection in the street, and shall charge the actual cost of cutting out and reinstating the water supply.

Section 16. Whenever any premises connected with the water supply system of the City of Seattle shall become vacant and the owner thereof desires to have the rates remitted for the nonuse of water on said premises, he shall file in the office of the Superintendent, not earlier than the first nor later than the tenth day of any month, a notice of vacancy for the preceding calendar month, giving the date premises were vacated, and if upon inspection it appears that the premises were vacant during the preceding month, the rates for the preceding month will be remitted, but no remission of rates will be made for a less period than one calendar month or without the notice prescribed in this section. This section applies to premises supplied at fixed rate only.

Section 17. All water rates will be charged against the premises for which the service was installed. All charges for water, when the same become delinquent and unpaid, shall be a lien against the premises to which the same has been furnished. In case any charges for water shall become a lien against any premises, the water shall be cut off until such charges are paid.

Section 18. When several houses, buildings or premises are supplied or to be supplied with water through one service connection with the city main the Superintendent may in his discretion either decline to furnish water until separate services are provided, or the service metered, or in case any one of the owners or occupants becomes delinquent or violates any of the provisions of this ordinance, the Superintendent may shut off the original or main service until all delinquent and unpaid charges and other charges,

are paid and the premises supplied by the main service shall be held responsible for all delinquent and unpaid charges against any one or all of the separate owners or users. No change of ownership or occupation shall affect the application of this section.

Section 19. All accounts for water shall be kept in the name of the owner of the premises for which the service was installed, and not in the name of any tenant; provided, that persons holding under recorded lease may be supplied on their own account, and in such cases the Superintendent may require such deposit of money with the Treasurer of the City of Seattle as in his judgment, shall be necessary to protect the city against any and all delinquent and unpaid charges for water, or other charges on account of such service

Section 20. It shall be the duty of the Superintendent of Buildings to report to the Superintendent of Water Works the beginning of construction or repairs of all buildings in the city, such reports to be a duplicate of the building permit issued containing a general description of the building to be erected or repaired, the name of the owner and contractor thereof, the official house number and street name, the lot, block and addition, together with an estimate of the brick, stone, cement, plaster or other material for which water is required to be used in the construction or repair of such buildings. Water for building purposes will only be furnished upon the application of the owner or authorized agent of the property. Applicants for water for building purposes shall pay the rates based upon such estimates as are verified by the water inspector. Water for construction purposes may be furnished by meter, and the payment for the same shall be made at the same time and in the manner as other meter rates. All water for building or construction purposes shall be charged against the property upon which it is used and the owner thereof, and all delinquent and unpaid charges therefor shall become a lien upon the premises supplied and be collected in the same manner as other delinquent and unpaid charges for water.

Section 21. It shall be the duty of the Plumbing Inspector to report in writing to Superintendent of Water Works all premises inspected by him where city water is used or about to be used, within forty-eight (48) hours after such inspection; such report to contain the name of the owner, the official house number and the name of street and the plumber performing the work, together with an accurate list of all new or additional fixtures installed on each separate premises. The Plumbing Inspector shall cause stop and waste cocks to be so placed as to thoroughly drain all the pipes and fixtures on each separate premises.

Section 22. It shall be the duty of the Commissioner of Health to report in writing to the Superintendent of Water Works all buildings or premises condemned or closed by his orders, such reports to contain the official house number and the street name and the name of the owner of such buildings or premises and the date same were vacated, and he shall again

report to the Superintendent in the same manner the date of reoccupation of each of such buildings or premises.

Section 23. It shall be unlawful for any person to carry on the business of plumbing, make any connections with any service or branch pipe thereof, or make any repairs, additions or alterations of any pipe, stop, or waste, water closet, or any other fixture connected with or designed to be connected with the city water system, except in compliance with this ordinance. He shall first deposit Twenty-five Dollars ($25.00) with the City Treasurer as a guarantee of the proper performance of his work and to indemnify the city for any charges or penalties that may be imposed for work done on his account.

The Superintendent may then furnish said person with a service key, which he shall keep in his possession and with which he may shut off the curb cock for the purpose of making repairs within the premises. No person other than plumbers who have complied with the above requirements shall use this key, and the plumbers shall leave curb cock shut off on all premises which are newly connected, and on all other premises the curb cock shall be left in the condition in which it was found, and on the completion of all work they shall notify the Superintendent. This shall not be construed as in any way relieving any plumber from making applications and complying with all the requirements of this ordinance. On failure to perform work in a proper manner, or in accordance with the requirements of this ordinance, the Superintendent may remedy or cause the same to be remedied, and charge the cost, together with any penalties which may attach, to the plumber, or deduct from his deposit; and in this latter event said plumber shall make whole his deposit before he will be allowed to do any of the work above specified. No private person will be allowed to do any of the above work unless by special permission of the Superintendent and the deposit of such sum as he may designate.

A transcript of the rules and regulations in this ordinance regulating plumbers may be obtained from the Superintendent, and shall be posted in a conspicuous place in all plumbing shops. The Superintendent may require that application for tap or additional fixtures be made and proper proof given of where water is to be obtained before plumbing permit will be issued.

Section 24. Any plumber or other person who shall violate any of the provisions of the preceding section shall forfeit his deposit to the City Water Department, and will be prohibited from performing any of the work prescribed in the preceding section for a period of one (1) year from the date thereof.

Section 25. The use of water for sprinkling or irrigating lawns, gardens, flower beds, plants, trees, shrubs or parking strips, or for hosing windows, woodwork, porches, steps or walks, except during such hours as hereinafter provided, is prohibited.

Cedar River Valley Above Lake. Cedar Lake in Distance

Section 26. The Superintendent is hereby authorized, empowered and directed to, on or before the fifteenth (15th) day of April of each year, and from time to time and as often as he shall deem necessary, divide the city into irrigation districts, within which districts water may be used at the times in this ordinance authorized for sprinkling or irrigating lawns, gardens, flower beds, plants, trees, shrubs or parking strips, or for hosing windows, woodwork, porches, steps or walks in each of such districts respectively, and he shall cause notice thereof to be published in the city official newspaper for one week, and may in his reasonable discretion cause the same to be published in such other daily newspapers published in the city, and at such times as he may deem necessary, and from and after the official publication of such notice it shall be unlawful for any person to violate any of the provisions thereof by using water for the purposes specified at any other time or in any other manner than as prescribed in such notice.

Section 27. Water used for any of the purposes mentioned in the preceding section from any service not connected with a meter and delivered through a hose, must be delivered through a nozzle the orifice of which is in no case greater than one-fourth (¼) of an inch in diameter, and said hose and nozzle must at all times while water is being delivered through the same for the purposes above mentioned be held in the hand of some person, and no hose having an inside diameter greater than three-fourths (¾) of an inch shall be used for delivering water for such purposes, and no water shall be delivered through a hose unless the same has a nozzle attached thereto as hereinbefore provided. Irrigation will be permitted on a lot of not more than sixty (60) by one hundred and twenty (120) feet, or its equivalent area, used as a lawn or garden and occupied by a building used as a dwelling, together with the right to use not more than one (1) set of hose, provided said premises are paying annually not less than the minimum rate. The use of additional hose or of water for irrigating a larger tract than as specified above or on premises paying less than the minimum rate will not be permitted, unless such premises are supplied through a meter and the water paid for at meter rates fixed by ordinance. The use of water for irrigating purposes through automatic sprinklers is prohibited, unless the service to which such sprinklers are attached is connected with a meter. Water may be delivered daily through such hose and nozzle between the hours of seven (7) o'clock and eight-thirty (8:30) o'clock a. m. and between the hours of seven (7) and eight-thirty (8:30) o'clock p. m., provided, that the Board of Public Works, in case of emergency, whenever the public safety, health or the equitable distribution of water so demands, may direct the Superintendent to change, reduce or limit the time above stated or to discontinue the use of water for the above purposes for such time and in such localities as in its judgment public necessity demands.

It shall be unlawful for any person to use water for any purpose mentioned in the preceding section through any other size of hose or nozzle than as herein prescribed, or through any leaky or defective hose or nozzle,

or through more than one (1) set of hose, or through a hose with a nozzle detached, or through such hose with or without such nozzle attached, at any time or times other than herein authorized except from any service connected with a meter, and water paid for at meter rates as fixed by ordinance.

It shall be unlawful for any person wilfully to place any automatic sprinkling device or wilfully to place or hold any hose in such position or manner that water therefrom falls on any person while on any public street or sidewalk.

Section 28. If any person shall violate any provision of the preceding section, the Superintendent shall shut off the water furnished to the premises upon which such violation is made, and shall charge two (2) dollars for shutting off and again turning on such water. In any such case the Superintendent shall not again turn on such water until all unpaid and delinquent charges for water, and other charges, have been fully paid.

Section 29. It shall be unlawful for any person to use any water for irrigation or sprinkling during the progress of any fire in the city, unless for the protection of property, and all irrigation and sprinkling and the use of all elevators shall be immediately stopped when an alarm of fire is sounded in any part of the city, and shall not be begun again until the fire is extinguished. In case of a shortage of water, the Superintendent may shut off all water used for elevator and sluicing purposes without notice.

Section 30. The city reserves the right at any time, without notice, to shut off the water supply for repairs, extensions, non-payment of rates, or any other reason, and the city shall not be responsible for any damage, such as bursting of boilers, supplied by direct pressure; the breaking of any pipes or fixtures, stoppages or interruption of water supply, or any other damage resulting from the shutting off of water.

Section 31. The service pipes, connections and other apparatus within any private premises must be kept in good repair and protected from freezing at the expense of the owner or lessee, who will be responsible for all damages resulting from leaks and breaks. In case of neglect to promptly repair any service or fixtures, or make any changes or alterations required in this ordinance, the Superintendent shall have authority, when deemed necessary, to go on the premises and make or cause to be made such changes, alterations or repairs, and charge the same against the premises and the owner thereof.

Section 32. It shall be unlawful for any person to waste water or allow it to be wasted by imperfect or leaking stops, valves, pipes, closets, faucets or other fixtures, or to use water closets without self-closing valves, or to allow any pipes or faucets to run open to prevent the service from freezing, or for any other reason or to use the water for purposes other than those named in the application upon which rates for water are based, or for any other purpose than that for which his contract provides, or to use it in violation of any provision of this ordinance.

Section 33. If any person violate any provision of the preceding section, the Superintendent may, in his discretion, without notice, place a meter on such service where premises are supplied at fixed rates, and may charge for the water measured at meter rates; and unless such person shall make the proper repairs and stop the waste, the water shall be cut off and shall not be turned on again until delinquent and unpaid charges have been paid and proper repairs made, and until there has been paid a charge of Two Dollars ($2.00) for shutting off and turning on such water service.

Section 34. Water fixtures will be assessed for each and every purpose for which they are available, and for each family or establishment within the inclosure, or when separated only by a door, gateway or other means of easy access.

Section 35. Services for fire protection must be metered and fitted with such fixtures only as are needed for fire protection and entirely disconnected from those used for other purposes. Persons having such services shall be charged not less than the minimum rate, charged for a metered service. No charge will be made for water used in extinguishing fire if the owner or occupant of premises where such fire occurs gives written notice to the office of the Superintendent within thirty (30) days from the time of such fire. In no case shall any tap be made upon any pipe used for fire service purposes, or any tank connected therewith, nor shall the use of any water be permitted through any fire service nor through any pipes, tank or other fixtures therewith connected for any purpose except the extinguishing of fire on the premises.

Section 36. It shall be unlawful for any person to fail, neglect or refuse to give the Superintendent and his duly authorized representatives free access at all reasonable hours to all parts of buildings or premises supplied with water from the city's mains for the purpose of making assessments, inspecting the condition of pipes and fixtures, noting the amount of water used and the manner in which it is used.

Section 37. If any owner or occupant of any premises supplied with city water shall violate any provision of the preceding section, the Superintendent may shut off such service; and such owner or occupant shall be required to pay any and all delinquent and unpaid charges against such premises together with a charge of Two Dollars ($2.00) for shutting off and turning on such water before the same shall be again turned on.

Section 38. In case of any violation of any of the preceding sections, the Superintendent may cause a written notice thereof to be served on the owner or occupant of the premises where such violation takes place, which notice shall require the payment of the charges hereinabove provided, and if such charges be not paid within twenty-four (24) hours from the time of the service of such notice, the water shall be turned off from such premises and shall in no case be turned on until the charges have been paid.

Section 39. The Superintendent is hereby authorized and directed to install a meter on the service of every person who is now or may be here-

after granted free water by ordinance, and to take the readings of such meters and enter the same in the books of his office in the same manner as other meter readings are taken and entered, and to, at the expiration of any three (3) months chosen by the Superintendent after the time of installing such meter, compute the average monthly consumption of water for said three (3) months, and thereafter all water consumed in any manner in excess of said average monthly consumption shall be charged and collected for at the regular meter rates as fixed by this ordinance.

Section 40. All meters, unless otherwise authorized by the Superintendent, shall be and remain the property of the city and will not be removed unless the use of water on the premises is to be entirely stopped or the service connection discontinued or abandoned. In all cases where meters are lost, injured or broken by carelessness or negligence of owners or occupants of premises, they shall be replaced or repaired by or under the direction of the Superintendent and the cost charged against the owner or occupant, and in case of non-payment the water shall be shut off and will not be turned on until such charge and the charge for turning on the water are paid. In the event of the meter getting out of order or failing to register properly the consumer shall be charged on an estimate made by the Superintedent on the average monthly consumption during the last three (3) months that the same was in good order, or from what he may consider to be the most reliable data at his command.

Section 41. Where the accuracy of record of a water meter is questioned, it shall be removed at the consumer's request and shall in his presence be tested in the shops of the Water Department, by means of the apparatus there provided, and a report thereon duly made. Both parties to the test must accept the findings so made. If the test discloses an error against the consumer of more than three per cent in the meter's registry, the excess of the consumption on the three previous readings shall be credited to the consumer's meter account, and the Water Department will bear the entire expense of the test, and the deposit required as hereinafter prescribed shall be returned. On the other hand, where no such error is found, the person who has requested the test shall pay the charge fixed for such test.

Before making a test of any meter the person requesting such test shall, at the time of filing his request with the Superintendent, make a deposit with the City Treasurer of the amount charged for such test, subject to the conditions herein stated, which charges are fixed as follows:

For testing ½ in. meters	$1.00
For testing ¾ in. meters	1.00
For testing 1 in. meters	1.50
For testing 1½ in. meters	1.50
For testing 2 in. meters	2.00
For testing 3 in. meters	3.00
For testing 4 in. meters	4.00
For testing 6 in. meters and greater	5.00

No meter shall be removed, or in any way disturbed, nor the seal broken, except in the presence or under the direction of the Superintendent.

Section 42. No charge will be made for the original installation of any meter unless such installation shall be of a temporary nature, when the Superintendent may require a deposit to cover the cost of installation and removal.

When it is desired to have a meter removed or reinstalled the owner of the premises supplied or to be supplied by such meter shall file an application at the office of the Superintendent on forms provided for that purpose, and shall pay the cost in full for such removal or reinstallation. Premises supplied by meter will not be reopened on a fixed rate.

Section 43. For the collection of fixed rates the city shall be divided into three districts, to be known as the First, Second and Third Districts, and described as follows:

First District: Including all that portion of the City of Seattle lying south of Union Street and East Union Street.

Second District: Including all that portion of the City of Seattle lying between Union Street and East Union Street and West Galer Street, Galer Street and East Galer Street.

Third District: Including all that portion of the City of Seattle lying north of West Galer Street, Galer Street and East Galer Street.

All fixed rates shall be due and payable as follows:

In the First District: During January, for January, February and March; during April, for April, May and June; during July, for July, August and September; during October, for October, November and December.

In the Second District: During February, for February, March and April; during May, for May, June and July; during August, for August, September and October; during November, for November, December and January.

In the Third District: During March, for March, April and May; during June, for June, July and August; during September, for September, October and November; during December, for December, January and February.

For the collection of meter rates the city shall be divided into three districts, to be known as the First, Second and Third Districts, and described as follows:

First District: Including all that portion of the City of Seattle lying south of Yesler Way. Bills delinquent 10th day of each month.

Second District: Including all that portion of the City of Seattle north of Yesler Way and south of Lake Washington Canal. Bills delinquent the 20th day of each month.

Third District: Including all that portion of the City of Seattle north of Lake Washington Canal. Bills delinquent the last day of each month.

All meter rates shall be due and payable as follows:

In the First District: From the 1st to the 10th day, inclusive, of each month.

In the Second District: From the 10th to the 20th day, inclusive, of each month.

In the Third District: From the 20th to the last day, inclusive, of each month.

If the above rates are not paid as prescribed in this section, the water may be shut off without notice, in which event an additional charge of One (1) Dollar will be assessed for shutting off and turning on, and said charge shall be paid before the water will again be turned on.

Failure to receive mail will not be recognized as a valid excuse for failure to pay rates when due. Change in ownership of property and change in mailing addresses must be filed in writing at the office of the Superintendent on forms provided for that purpose. The Superintendent may require payment in advance or satisfactory security for all water to be furnished by meter, and if such payment be not made, or security furnished within the time fixed by the Superintendent, water shall be shut off from the premises.

Section 44. It shall be the duty of the Superintendent to keep accounts with all consumers of water, to enter on such accounts all charges and penalties, and the Superintendent is authorized and empowered to, from time to time, and as often as the proper administration of his office shall require, district and redistrict the city and fix the day of the month on which charges and penalties charged against consumers of water shall become due in each of such districts. Whenever the superintendent shall so district or redistrict the city and fix dates, he shall cause notice thereof to be published in the city official newspaper and may cause such notice to be published in such daily newspapers published in the city as he may deem expedient.

Section 45. The monthly rates for use of water other than measured by meters shall be known as "Fixed Rates," and shall be as follows:

Minimum rate, payable quarterly in advance, per month	$0.65
Bath tubs in private residences, one tub	.20
Each additional tub	.15
Building purposes, for plastering, per 100 yards	.20
For each 1,000 brick laid, including water for lime	.15
Wetting each barrel of lime for any purpose other than plastering or laying brick	.10
Wetting each barrel of cement	.10
Stone work, per perch of 16½ cubic feet	.10
Cows, for each cow, whether supplied by house service or otherwise	.20
Earthwork, for settling each 100 cubic yards of earth	1.40
Family rates, 8 persons or less using the same kitchen (water closets and baths additional)	.65
Each additional person	.10
Horses and mules in private stables, whether supplied from house service or otherwise, each	.20
Paving and laying sidewalks, concrete, per 100 square yards or less, for 6-in. base or less	.50

Portable engines, for first horsepower	.80
Each additional horsepower	.20
Water closets in private residence, one	.20
Each additional	.15

Section 46. Water for the following purposes shall be served by meter and charged for at meter rates:

Bakeries, barber shops, bath tubs in hotels, boarding houses, public buildings, barber shops and bath houses, beer pumps, blacksmith shops, book binderies, breweries, brick yards, butcher shops, fish markets and grocery stores, candy factories, club rooms, dancing halls, dry goods stores, drug stores, dyeing and cleaning establishments, dairies, engine houses, foundries, greenhouses, garages, gas companies, gardens for market purposes, government, county and state buildings, hotels, boarding and lodging houses, hydraulic elevators, ice cream parlors and soda fountains, laboratories, soda manufactories, bottling establishments, vinegar factories and packing houses, laundries, lawn fountains, lunch counters, machine shops, manufactories and shops, office buildings, oyster stands, photograph galleries, Police Department, police buildings and jail, city stable, printing offices, public halls and theaters, restaurants and coffee houses, saloons, schools, public or private; sleeping rooms, sprinkling streets, sale, livery and boarding stables, steam and gas engines, stationary urinals, wholesale liquor houses, comfort stations.

Water used for all other purposes or kinds of business not hereinbefore enumerated shall be furnished and charged for either at meter rates or at a special rate to be fixed by the Superintendent.

Section 47. The rates for water supplied through meters shall be as follows, for a month or fractional part thereof:

500 cubic feet, or less	$0.50
Provided that where two or more separate buildings or premises are supplied by the same meter the minimum rate shall be Fifty (50) Cents per month for each such building or premises, as long as the meter remains on the service through which water is supplied.	
Exceeding 500 cubic feet, per 100 cubic feet	.06
Except that for manufactories, laundries, motors, and elevators, the rate for all water used in excess of 30,000 cubic feet shall be, per 100 cubic feet	.04

Section 48. In all cases where water is furnished for purposes other than manufactories, motors, laundries and elevators on the same service, separate meters must be provided and the water consumed charged for at schedule rates, and such consumers must pay for all service connections as provided in this ordinance.

In computing meter rates and meter rents, as provided above, results ending in one and two cents will be counted "0"; results ending in three, four, six or seven cents will be counted "5"; results ending in eight or nine cents will be counted "10."

Section 49. It shall be the duty of the employes of the Police, Fire, Engineer's and Streets and Sewers departments to give vigilant aid to the

Superintendent in the enforcement of the provisions of this ordinance, and to this end they shall report all violations thereof which come to their knowledge to the office of the Superintendent, and it shall be the duty of the Chief of the Fire Department to report immediately to the Superintendent in case of fire in premises having metered service for fire protection purposes that fire has occurred therein.

Section 50. A copy of this ordinance may be obtained by all owners of property and consumers of water, and shall be considered a part of the contract made between the city and every such owner and consumer.

Section 51. It shall be unlawful for any person, except when duly authorized by the Snperintendent, or who shall be a member of the Fire Department, to open, operate, close, turn on, turn off, interfere with, attach any pipe or hose to or connect anything with any fire hydrant, stop valve or stopcock belonging to the city.

Any person, other than employes of the Fire Department, requiring the use of any hydrant, stopcock or valve belonging to the city must make written application for the same in advance to the Superintendent. The Superintendent shall then send a hydrant inspector to open such hydrant, stopcock or valve and the time of such inspector shall be charged to the person making application for the use of such hydrant, stopcock or valve. Should it be necessary for the inspector to remain at the hydrant, stopcock or valve until the person using the same has secured the necessary supply of water, the full time so consumed by the inspector shall be charged to the person securing such service, but in no case shall the charge be less than one (1) dollar. The Superintendent may require a deposit in advance as a condition for supplying such water.

Section 52. It shall be unlawful for any person, unless duly authorized by the Superintendent, to disturb, interfere with or damage any water mains, water pipe, machinery, tools, meters or any other appliances, buildings, improvements, lawns, grass plots, flowers, vines, bushes or trees belonging to, connected with or under the control of the Muncipal Water Supply System of the City of Seattle.

Section 53. It shall be unlawful for any person to bathe in, fish in or throw any substance into any reservoir, or place any foreign substance upon any grounds belonging to, connected with or under the control of the Municipal Water Supply System of the City of Seattle.

Section 54. It shall be unlawful for any person to obstruct the access to any fire hydrant by placing around or thereon any stone, brick, lumber, dirt or other material, or to open or operate any fire hydrant, or draw or attempt to draw water therefrom, or to wilfully or carelessly injure the same.

Section 55. It shall be unlawful for any person to make connections with any fixtures or connect any pipe with any water main or water pipe belonging to the Municipal Water Supply System, without first obtaining permission so to do from the Superintendent.

Section 56. Any person violating any of the provisions of this ordinance shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine in any sum not exceeding one hundred ($100) dollars, or imprisoned for a term not exceeding thirty (30) days, or be both so fined and imprisoned.

Section 57. The Superintendent shall cause a reward not to exceed ten (10) dollars to be paid to any person securing the conviction of any person for violation of any of the provisions of this ordinance.

Section 58. The Superintendent shall have authority to decide any question which may arise and which is not fully covered by any of the provisions contained in this ordinance, and his decision in such cases shall be final.

Section 59. All ordinances or parts of ordinances in conflict with the provisions of this ordinance are hereby repealed.

Section 60. This ordinance shall take effect and be in force thirty days from and after its passage and approval, if approved by the Mayor; otherwise it shall take effect at the time it shall become a law under the provisions of the City Charter.

Passed the City Council the 24th day of March, 1913, and signed by me in open session in authentication of its passage this 24th day of March, 1913.

ROBT. B. HESKETH,
President of the City Council.

Approved by me this 2nd day of April, 1913.

GEO. F. COTTERILL,
Mayor.

Filed by me this 2nd day of April, 1913.

Attest:

(SEAL) H. W. CARROLL,
City Comptroller and ex-officio City Clerk.

By J. P. AGNEW,
Deputy Clerk.

Published April 9, 1913.

Riprapping and Cribbing to Protect New Bridge on Pipe Line

Reasons for Rules

The Rules and Regulations which govern the operations of the department and which are incorporated in the above ordinance, are the result of many revisions based upon an experience of twenty-three years of plant operation. Water users sometimes complain about these rules with but little understanding of the long series of experiences that have led up to their adoption.

I will explain the reason for some of the more important of these rules.

House Numbers: People applying at the water office for new taps to their premises are required to present the official number of their premises as given by the Building Department. This is to do away with errors and uncertainties in house numbers, the responsibility for their correctness being thrown upon one department which issues the official number.

Service Connections: "No premises shall be allowed to have more than one service connection."

This does not apply to premises that had more than one service connection before the adoption of this rule, but only to those houses connected up after the adoption of the rule. Thousands of houses had been connected on services originally installed for some other premises. These are allowed to remain as they were until new mains are installed on the street upon which they front. They are then required to take out new taps. Long experience shows that where several houses are connected on the same service, any one of these houses by failing to pay water rent can embarrass all the others and cause their supply to be cut off. The system is not just, because each of such houses receiving an equal benefit with premises that have paid for a tap, should be placed on the same footing in its relation to the Department.

Standard Pipe: Water users are required to install standard galvanized pipe. The reason of this is that the ordinary black pipe is unfit for anything but temporary use. It fills with rust in a few years and stops the supply, requiring constant renewals and repairs. The rust finds its way into the meters and clogs their movement or chokes them up so that they do not run at all. The expense of maintaining such services, including the cleaning and repairs of meters, would be many times the cost of maintaining the service with galvanized pipe.

Stop and Waste: Each service must be provided with a stop and waste so located within the premises as to permit draining of the house pipes during freezing weather. This provision is necessary, not only for the protection of the house from being flooded by broken pipes, but also to prevent waste of water through leaks caused by frost, and the draining of the reservoirs in freezing weather by users who allow their faucets to run all night to prevent their pipes from freezing. This latter result had taken place more than once before this rule was adopted and enforced.

House Vacancies: Users are required to file vacancy notices between the 1st and 10th day of the month just succeeding the calendar month during which the premises have been unoccupied. This provision is for the purpose of keeping the Department informed so that claims for vacancies can be checked up and verified by inspectors before it is too late. After the lapse of many months, verification of many vacancies would be difficult or impossible, and the Department would have to allow the claim on the strength of the unsupported testimony of the owner, a plan which would be unworthy of consideration as a method of doing business. For the same reason when a user wishes to discontinue the use of water through any of his faucets, as for instance a bath or a stable, he is required to cut and plug the branch pipe leading to that faucet, and notify the Department to that effect. It is very properly assumed by the city that when any fixture is immediately available for use it will be used when the user sees fit to do so. There is a charge of $1.00 made by the Department for the work of shutting off and turning on water to a premises at the request of the owner, because such a service is not properly a part of the general business of supplying water, but rather a special service rendered the consumer for his individual benefit.

Additional Fixtures: Plumbers are required to take out a permit for all work done on house pipes so that the Department will have knowledge of any additional fixtures installed on each premises.

Water Wastage: A number of regulations were adopted to prevent the wastage of water by persons taking water on a fixed rate per month. All these regulations were necessary, but some of them were annoying to the user. Since 85 per cent of our services have been metered the aggregate wastage is not so great and very stringent regulations to prevent wastage are not so necessary. Still it is clearly unjust to allow the irresponsible user on a fixed rate to use or waste many times as much water for a given price as

the man who takes through a meter and must pay for what he gets. The system of supplying through fixed rates is obsolete, unfair, loose and unbusinesslike, and should be done away with altogether.

Fire Protection Services: Services for fire protection must be metered and maintained separate from those used for domestic or business purposes. This rule is necessary because no charge is made for water used to extinguish fires. It was desirable to adopt some means of discovering whether any water passed through the fire service that was not used for extinguishing fires. To accomplish this purpose it was found necessary to devise a special form of meter that could be built cheaply, which, while not registering the actual amount of flow, does register a flow through a by-pass if any water is being used at any time.

Testing Meters: Under a system which required the Department to test meters upon request of the consumer, and without expense to the latter, the number of tests ordered would approximate very closely the number of persons who thought their meter was registering too high. This would mean some thousands of tests each year, which in view of the almost certain proof of correctness on test, would be a useless waste of public money. Under the system of requiring the consumer to make a deposit of a sufficient sum to cover the expense of a test, the amount so deposited to be returned to him in case the meter shows a registration of more than three per cent against him, the number of tests ordered is inconsiderable, amounting to less than 100 in the last three years. The result of these tests as shown in a subsequent part of this report justifies the statement that a system of free tests serves no good purpose compared with its cost.

In this connection it is worth noting that a meter is now installed on each new service, but the consumer is charged for the tap only. As the meter is just as much a part of his private water equipment as the tap, there seems to be no good reason why he should not pay for it at the same time that he pays for the tap.

Failure to Receive Mail: Failure to receive mail is not recognized as a valid excuse for failure to pay rates when due. Changes of ownership and mailing address must be filed in writing at the office of the Superintendent.

The first of these provisions is necessary as the Department has no means of knowing whether the mails fail or not, and if such an excuse were permitted without verification the effect on collections would be serious, if

not disastrous. Every consumer is presumed to know that his meter rates must be paid monthly and his fixed rates quarterly, and if a bill fails to reach him during the proper month he is supposed to inquire at the office either personally or by telephone, and settle the account.

As to the second provision, the Department has no means of knowing when a change of ownership or mailing address takes place, unless notice of same is filed at the office, so that where mail fails to reach the proper person on account of change of address the fault cannot be charged against the Department, unless the mail is misdirected by clerical error.

The Emerson Efficiency Report

During the year 1912 The Emerson Company of New York, Efficiency Engineers, made an investigation of the methods of business in the city departments and submitted several recommendations. The City Council, by Resolution No. 4053, adopted May 5, 1913, requested the various city departments to report to the Council how far the recommendations of the Emerson Company could be applied for the purpose of increasing the efficiency of the departments. In response to this resolution I had the honor to submit the report which follows, and as the matters therein discussed constitute presumably the most important improvements that a capable intelligent investigator, without special training in Water Department business, can suggest, they are well worthy of presentation in this report. I print in full, therefore, the Department review of the Emerson report.

Honorable City Council, June 12, 1913.
Gentlemen:

In accordance with Resolution No. 4053, adopted by your honorable body on May 5, 1913, I transmit herewith a brief statement of the matters set forth and the recommendations presented by the Emerson Company of New York, with reference to the methods of operation in the City Water Department. It is proper that I should state that where I believe these recommendations to be of value I will cheerfully accord them the merits to which they are entitled. On the other hand, where the recommendations are manifestly made upon a basis of information concerning the Department which is altogether too meager upon which to frame general conclusions, it will be necessary for me to state the grounds upon which I must differ from the recommendations of the Emerson Company, thus giving to your honorable body an impartial comment upon the document, which is

the result of my experience as Superintendent of the Water Department for the last eighteen years.

In their introduction to the general discussion they claim that the outlay for construction and equipment, *i. e.*, capital assets, is larger than it ought to be. This is a very broad statement, and could be made with safety only after an exhaustive examination of the expenses of construction during the twenty-three years since the city purchased and has operated the plant. It would, of course, be impossible for the Emerson Company to make this investigation during the brief time which they gave to the examination of matters in the Water Department. It is probably based upon the assumption which the company makes further along in their report to the effect that the installation of water meters constitutes a needless expense, because more water is coming into the city through pipe lines than is actually needed for daily use. This matter will be dealt with further on.

On page 2 the Emerson Company make the statement that interest and reasonable depreciation on the total water plant investment will amount during the year 1912 to nearly $1,000,000. It is difficult to understand how the Emerson Company could have made this statement in view of the fact that the interest charge for the year 1912 was only $271,-253.49, while the rate of depreciation worked out by the Emerson Company on page 8 of their report amounts to only $84,867.62 on the entire plant.

It is unfortunate that these fundamental errors are made the basis of the Emerson Company's reasoning, as the deductions drawn from them must, of course, be wide of the mark when the premises are so radically erroneous. Taking the report as a whole there seems to be no escape from the conclusion that the time which the Emerson Company were enabled to devote to the investigation of the Department was wholly inadequate for the development of general conclusions that are well based and grounded on a careful analysis of the facts.

After stating that the interest and reasonable depreciation amount to nearly 1,000,000 per year, while the total operation expenses will not exceed $250,000, the Emerson Company, on page 2, proceed to state further that: "It is evident that close attention should be given to the efficiency of capital expenditure, not only as to economical and efficient prosecution of new constructions, averaging some $700,000 per year, but as to the necessity of incurring such expenditures at all, or in determining the proper time at which it may be efficiently incurred."

It is clear that the same thought runs through this statement as through the one previously quoted. It is not evident from the wording of this statement in regard to construction whether the Emerson Company takes into account expenses incurred for the installation of distributing mains under the local improvement provisions of the charter. This element of cost, as all city officials know, is not distinctly under the control of the Council or the heads of departments, being settled upon by the people themselves by majority petition when they want distributing mains installed. It is, there-

fore, not subject to regulation at the will of the city government. I will revert to this matter furher on.

Reviewing the general items of investment heretofore incurred under subdivision 1, the company concedes the efficiency of the expenditure of $1,286,000.00 for real estate, chiefly for the purpose of insuring the purity of the water for drinking purposes, and suggest that a large part of this expense can be recovered by the sale of timber, and that this should be done as rapidly as practicable in order to reduce the amount of this annual charge. This suggestion of Mr. Emerson is of very doubtful value. The immediate sale of all the timber on the watershed, which has increased in value and will, doubtless, increase in value much more than five per cent per annum, in order to cancel a debt that bears only five per cent interest, looks to me like a losing transaction. I think the judgment of any buyer of timber would confirm this view. The timber for the purchase of which a contract has recently been let, covers only that part of the watershed which will be overflowed when the masonry dam is completed to its full height, which is an inconsiderable area compared with the whole water shed. It had to be sold or totally lost by being left under water.

In subdivision 2, the company concede the necessity of pipe lines No. 1 and No. 2 and admit that the construction of No. 2 is not premature for the reason that prior to its completion the city was frequently confronted with an actual shortage of water. The company also suggest that the labor and construction of these two pipe lines was inefficient. If so, then the inefficiency was on the part of the contractors, and not on the part of the city, as both pipe lines were built by contract, and the contracts let to the lowest bidders.

This is equally true with respect to nearly all the construction work heretofore done, which, in Mr. Emerson's opinion, has cost too much. Practically all of it was done by contract.

In subdivision 3, referring to the purchase of old water systems for the sum of $507,000.00, the company notes their inefficiency, which is true as compared with the first-class work of this nature which is installed by the city. However, these systems were bought at prices far below their original cost, so that the service which they rendered to the city was doubtless commensurate with the price paid. Had these systems not been purchased the city would have been compelled, immediately upon the absorption of new territory, to build new mains of first-class quality at the usual cost of such construction. On the other hand, in the case of the City of Ballard, the whole system of distributing mains was turned over to the city without cost, which, considering their magnitude, would more than offset the amount paid for all the other systems which the city acquired, not including, of course, the original $350,000.00 paid for the Spring Hill Water System in 1890.

In subdivision 4, the company notes the fact that no depreciation was charged off against reservoirs, standpipes and tanks, and computes the de-

preciation at five per cent on all of these installations, amounting to $56,822.00 a year. In this item of $1,336,441.00, which they state as a total cost of the three constructions, the tanks and standpipes average approximately $100,000.00, so they constitute a comparatively small item in comparison with the cost of the reservoirs. Admitting some depreciation on standpipes and tanks, it is plain that with no depreciation on the reservoirs, the cost of which, according to Mr. Emerson's figures, aggregate over $1,300,000.00, the $56,822.00 annual depreciation would be reduced to approximately $5,000.00. Concrete construction tends to become stronger rather than weaker from year to year. It is well known that much of the concrete work put in thousands of years ago is as strong or stronger than work that was installed last year. So it is not necessary to figure depreciation on work of this class. As to the wooden tanks in West Seattle and elsewhere, Mr. Emerson is right in his view that they should be replaced as soon as possible with more sightly and permanent structures. The Department long ago recommended this and had bought land for that purpose before Mr. Emerson's arrival in Seattle.

In subdivision 5, Mr. Emerson suggests that as a matter of economy city bonds should have been issued bearing four and one-half per cent or five per cent interest and the proceeds devoted to the construction of the $4,000,000.00 of local improvement mains, the city taking in lieu of this local improvement district bonds at 7 per cent, which, he says, would eliminate the necessity of charging the municipality for the public use of water. As a purely theoretical proposition this plan appears to be a good one, though it is wholly improbable that it could ever be carried out. Property owners would not sanction and sustain an arrangement of that sort. The difference of two and two and one-half per cent between the rate of interest paid by the city and the rate charged against the property owner would be a constant bone of contention while it lasted, and the plan would probably be nullified by popular vote before it had been in force any great length of time.

In subdivision 6, Mr. Emerson notes the cost of meters installed as $488,000.00, the annual interest upon which, plus depreciation of seven per cent, would make a fixed charge of $58,000.00 He says: "We consider this investment in great part inefficient, unnecessary and premature, in that it adds materially to operation costs, while economizing water, for which no demand exists and which must be allowed to run to waste." I recur now to Mr Emerson's original statement that the capital outlay for construction has been larger than it ought to be, and subsequent statement that close attention should be given to capital expenditure, partly as to the necessity of incurring such expenditure at all, or in determining the proper time at which it may be efficiently incurred. The gist of this matter seems to have been overlooked by Mr. Emerson, probably on account of his slight familiarity with the history, experience and operation of the

plant. The fact is that the consumption of water if supplied at fixed rates would absorb fully one-third to one-half more of the deliveries of the pipe line during the irrigation season than if supplied through meter (even with the present supply) and assuming that both pipe lines could be kept in commission steadily during the hot season, there would doubtless be an outcry for more water as soon as the use under the fixed rates became excessive. It is perfectly safe to say that with the distributing mains of their present extent and capacity you could turn the whole flow of Cedar River into the reservoirs, the dry season, and all the high districts of the city would be without water during irrigation hours under a system of fixed rates. I speak conservatively when I say that the necessity for constructing a new pipe line would occur fully five years sooner than it otherwise would if there were no meters installed. As the total cost of all the meters has been substantially $500,000.00, while the cost of an additional pipe line having the capacity of No. 2 would be from three to four times that amount, it is evident that the interest and depreciation on a new pipe line which had to be constructed five years sooner, would amount to far more than the interest and depreciation on the cost of all the meters installed. How the Emerson Company could have overlooked these vital considerations I do not understand. A secondary, but perhaps lesser consideration, is the danger that during the irrigating season one of the pipe lines may fail, which is particularly dangerous in the case of No. 1 after twelve years' service. If this should take place when people are using water lavishly on fixed rates, the high districts would doubtless be without water not only for fire protection, but for domestic and irrigation purposes as well. Such a possibility should be guarded against, and the best means of doing it is to protect the supply by the installation of meters.

Mr. Emerson suggests the putting in of meters on service pipes of two inch diameter or over, where the opportunity for waste is larger. As a matter of fact the wastage does not occur to any great extent on meters of two inch diameter or over, as these meters are used for business and commercial purposes, where there is no incentive to waste and where business methods are more likely to prevail in the care of equipment. Most of the waste occurs in residences from defective fixtures and from allowing fixtures to run for irrigating purposes for many continuous hours where there is no real need of the water.

Mr. Emerson's suggestion with reference to keeping on hand only such supplies and material as will be needed before fresh orders can be delivered, thereby maintaining the stock at as low a point as possible consistent with safe and expeditious work, is simply a statement of the practice which the department has been following for years. The value of stock on hand has not materially increased in four years. A large part of this material, however, is not stock bought for use, but pipe, valves and other attachments that have been taken out to make way for larger ones as the city grows. It is evident that this material may remain in stock

a long time, awaiting the execution of some work not contemplated when the material was brought to the yard.

Mr. Emerson notes the fact that the interest on money presumed to be put aside each year to cover depreciation should be deducted from the sum written off for depreciation, reducing the rate of depreciation very materially. For example: instead of writing off two per cent flat for a fifty-year life, he would write off five-tenths of one per cent; instead of writing off five per cent flat for a life of twenty years he would write off only three per cent, and so on. These reduced net rates on the cost of the different parts of the plant would give a total depreciation of $84,867.62. This added to the $251,168.15 interest charge for 1912, would foot up $336,035.77 —instead of the $1,000,000.00 which Mr. Emerson estimates.

The Emerson Company also states that the separation of various materials in the same construction for the purposes of determining proper rates of depreciation for each, is needlessly complicated, and they go on to say that "It is a useless refinement as to wood stave pipe to figure one rate on steel bands and another on the staves." The matter does not impress me in that way. Time enough has elapsed to show that the depreciation in the wood stave is several times more rapid than that in the steel bands, and as the steel bands constitute by far the greater part of the cost of the pipe, it would certainly be a very loose computation that would lump the two things together and give the sum of the two a flat rate of depreciation. In any case if this were done the values should be equated in such a way that the relative cost would be made a factor in determining the rate.

Mr Emerson says that the useful life of these constructions, including obsolescence, is at best an engineering guess. I can not so regard it. Certainly enough experience has been secured in the use of wood and iron and concrete to form a fairly well-grounded judgment as to the period during which they will be economically valuable for the purpose for which they were installed. This may not be true with reference to complicated machinery which is constantly being replaced by improved types. The matter of obsolescence is important in the case of machinery, but in the case of the structural parts of a water system obsolescence may be regarded as insignificant. It is not at all probable that any new type of construction for wooden pipe will soon replace the present one, nor is it probable that any new type of concrete reservoir or cast iron pipe will soon replace what is used at present. While the question of durability of the various materials has not been reduced to a scientific nicety, experience has nevertheless determined the matter close enough so that rates based upon this experience are fairly close for such well known materials of construction.

As to the pay roll, which has shown a general tendency to become less during the last two years; that is a matter of record and can be ascertained by any one. While the number of watermains has increased from year to year, and the work contingent upon this increase has correspondingly grown, there has been a considerable reduction in the volume of local im-

DAM AND INTAKE AT LANDSBURG

provements, which has helped out materially in the matter of taking care of mains and services on streets where grading and paving operations are being carried on. On the whole, therefore, there has been a considerable reduction in the volume of the pay roll. Mr. Emerson refers particularly to the office pay roll, where the cost has been kept down notwithstanding the increased work, by the constantly increasing efficiency of the force as a result of long periods of service.

In the matter of sending out the meter bills quarterly, this has been thrashed out to a conclusion many times before the Emerson Company was employed to make an investigation. There is no question that fixed rates can be handled in this way very efficiently, because the amount of each bill on the whole does not vary greatly from month to month. Only in cases where additional fixtures are installed or removed, which is an uncommon thing in the case of houses built on modern plans, or in the case of vacancies, would there be a change in the bills. But in the case of meters great variations take place from month to month in the quantity of water used and the charge therefor. If the same parties occupied the premises and paid the bills from month to month the difficulty in keeping track of and adjusting these rates might not be so serious; but where not only the occupancy, but the ownership of property is being constantly changed from month to month, the changes in both cases running into the thousands each month, the number of complaints filed and adjustments to be made between the reading periods would be so great as to require the services of possibly two or three men outside and one or two men in the office. The reading on a meter would be taken, for example, a month before a family or business concern moved out of a premises. This family or concern might be using large quantities of water. Two months would then elapse before a reading was taken for the new occupants. This new family or business concern might not use one-half or one-fourth per month as much as the former one did. If notice were not sent to the office at the time the change of ownership or occupancy took place, which would be the case in most every instance, because people do not attend to these matters as a rule in a prompt and business-like way, the question would be constantly arising as to how much of the water was used by the first occupant and how much by the second. Of course, this would generally result in a wrangle, and would compel the department to make an arbitrary ruling, which is always disagreeable and unsatisfactory, and many times decidedly unjust, to the consumer. In view of the constantly shifting lines of business and occupancy, the department has never deemed it either economical or advisable to enter upon the experiment of a three months' reading or rendering of bills for premises which are supplied by water. Even in the case of a single firm variations in the quantity of water used from month to month are often very great, changing often as much as five hundred to a thousand per cent. This is due to the variations in the amount of business, and variations in the season, as for instance in

the case of fish packers and other like industries, and we find in such cases that where a meter is clogged or fails to register when we discover the fact it is very difficult to fix upon a just charge. This condition will be manifestly very much aggravated in the case of quarterly readings for the same firm, to say nothing of the difficulty of adjusting when change of occupancy or change of business has taken place during a quarter. In the case of leaks the meter might run a full three months without discovery, while now it is discovered in a month.

Mr. Emerson says that on original work, such as installing meters and making tap connections, "We find the men fairly efficient, but in general and diversified work in connection with construction, of which very little is in progress, and on reconstruction, repairs, etc., they average less than 75 per cent efficient." Upon what data he bases this latter statement I do not know. As far as our outside foreman or any of his men know, neither Mr. Emerson nor any of his representatives were on the ground observing actual operations on this outside work. However, I do not say that some representative of Mr. Emerson might not have been present at times when the men were working, observing the work in the attitude of a disinterested bystander. At any rate it would appear that there should be some concrete facts presented to justify such a sweeping statement. If the company had knowledge of such facts they should have been presented in the report.

The shops of the department, says Mr. Emerson, are large and well equipped, they are also well administered. They are inefficient, he says, in that as to space and equipment the investment proves unprofitable on account of the small amount of work to be performed, and he suggests that a general city shop would be more economical. As to this recommendation, I have for years urged the same thing in my annual reports and at one time drew plans for such a shop to be located at the south end of Lake Union.

As to the fire boat "Snoqualmie," to which Mr. Emerson refers the fact has been known to every City Council during the last twenty years that the boat is really a part of the fire department equipment, but was unfortunately paid for at the outset from water department funds and there has never seemed to be a sufficient desire on the part of the legislative authority of the city to reimburse the water fund for the outlay. Perhaps this is a case of what Mr. Emerson calls obsolescence.

Mr. Emerson says that the accounting in the water department is well handled, is simple and effective. It is my judgment that the system of accounting, while excellent as to results accomplished is rather cumbersome and expensive as to routine. The system was installed by the Price-Waterhouse Company, under the direction of the City Council There are doubtless some things that could be improved. The matter of reducing the cost of collection is being now considered by the superintendents of the water and light departments, in conjunction with the city treasurer.

The obsolete records to which Mr. Emerson refers have probably been kept longer than is absolutely necessary. The matter is one of no great importance. The space which they occupy is comparatively insignificant. Some of these records could be safely destroyed in two years and some perhaps should be kept five, but if no expense is incurred in the way of cabinets or shelves for their storage, the space which they occupy is a matter of but little consequence.

I can hardly believe that Mr. Emerson actually measured the dimensions of the two floors of the Prefontaine Building, in which the water and light offices are located. As the water department employs 48 people, including the inspectors and meter readers, and the lighting department about 75, for all of whom desk room has to be provided, the placing of both departments on one floor as he suggests, would be not only impracticable, but impossible.

I agree with Mr. Emerson that there is no obligation to provide a net revenue more than enough to retire the bonds in a reasonable period, which he puts at 30 years. Fortunately the department is practically doing this by paying over $200,000.00 a year on about 80 per cent of its indebtedness, most of the bonds being serial. The growing needs of the city will probably require more new construction each year than the amount of indebtedness retired. It is evident that this increased indebtedness should not exceed the increase of population. In view of the experience of cities generally if this latter result can be secured the department will be very fortunate. I would certainly recommend that any new bonded indebtedness should be issued in serial form, so that the liquidation will proceed from year to year, and not throw a heavy burden of debt on posterity, in addition to the great expenses which the next generation will necessarily incur for new construction. The redemption of bonds in annual installments if fixed at a proper amount will necessarily cover the depreciation from year to year, and I agree with Mr. Emerson that this annual redemption fund should be increased in the future rather than diminshed.

The present minimum rate of 50 cents per month, Mr. Emerson considers low enough, if not too low. I do not think there can be any doubt of this fact since the average investment for each premises supplied, exclusive of local improvement assessments, is approximately $200, the fixed charge upon which at five per cent per annum, to say nothing of redemption, would be $10 per year. Mr. Emerson computes that the minimum rate of 50 cents is not now self-supporting, and we believe that he is correct in this view. He computes the monthly cost to the department of each service at 69 cents and says what I have repeatedly asserted, that the large water consumers are carrying a part of the small consumer's load.

In conclusion the Emerson Company says "When the financial condition of the water department should justify a further reduction of charges, it should, in our opinion, be applied:

"First: In making all public use of water free.

"Second: In reducing manufacturer's rates.

"Third: In reducing rates per 100 cubic feet to large consumers."

With reference to reducing rates the proposition is undoubtedly advisable whenever possible. As to making the use of all public water free, referring undoubtedly to water consumed by the municipality, there is a question of equity involved in this case as between the class of citizens who pay water charges and the class of citizens who pay local improvement assessments. The latter class of citizens now are paying interest on a volume of local improvement assessments for watermains which represent in round figures about one-third the cost of the plant. The water consumers are paying on the other two-thirds. To make the public use of water free, would throw a disproportionate cost on consumers for the benefit of the general public and the parties paying local improvement taxes, for the consumers would then have to pay what the municipality did not pay. It is not clear to me that such a proceeding would be just to consumers, as the consumer now pays all the cost of operation besides the interest on two-thirds of the cost of the plant, as above mentioned.

Summarizing in a general way the facts set forth and the recommendations made by the Emerson Company, I am unable to discover a single matter in their report by which the department could profit in any way, or increase its efficiency, apart from what has been always known, practiced and applied in its administration. In every case where the company's recommendations have merit, the discovery which they presumed to have made is by no means new to the department, and the methods by which they propose to remedy the shortcomings have been thrashed out and reconsidered time and again since the water system passed under the control of the city. In cases where their recommendations are clearly ill-advised or erroneous, I have so stated in the previous paragraphs of this report.

I say this in all fairness to the Emerson Company, because while I believe that Mr. Emerson is a capable man, his report unquestionably reveals the fact that it is wholly impossible for any outside parties, however capable, to secure a sufficient knowledge of city affairs in a few brief months to enable them to instruct either the Council or the heads of the departments in better and more efficient methods of action, so that any statements which I have made should not be taken as a reflection upon any company or individual, but rather as showing the impossibility of doing the work of years in a few months, or supplanting a knowledge which men acquire by years of practice in particular lines of administration by theoretical ideas based upon limited experience, or none at all, in lines of business which they undertake to investigate.

Respectfully submitted,

(Signed) L. B. YOUNGS,

Superintendent of Water.

Suggestions from Citizens

We print here a few suggestions sent in by citizens with a view to the improvement of methods in handling the business of the department.

Many people think that the process of collecting rates both in the Water and Lighting departments can be cheapened. One suggestion is that the employment of collectors to go from house to house and render bills would be cheaper than the present method of mailing bills and receiving payment through the mails.

Another suggestion is that postage and envelopes could be saved by sending the bills of the Lighting and Water departments in the same envelope. Another that the reading of meters in the Water and Lighting departments should be done at the same time by the same meter reader.

A fourth suggestion is that meters should be read and bills rendered once every three months, instead of once every month.

The above are some of the more important suggestions that come to the office from time to time, and as those who send them in, are no doubt, seriously desirous of benefiting the department, and saving the public expense, the suggestions merit, and have received careful consideration from the department.

As to the matter of employing collectors, it is certain that the expense would be greater than collecting by mail, even when we take into account the postage paid on remittances to the department by water users. An estimate of the cost of the present method was made in October, 1911, and the result was as follows:

COST OF MAILING 29,014 WATER BILLS AND RETURNING 4,536 RECEIPTS IN AUGUST, 1911

29,014 accounts @ 2c. each would be	$580.28
By grouping the bills payable by each firm the number of stamps required is reduced to	
24,290 @ 2c. each	485.80
Putting accounts in envelopes and assorting 5 days	16.35
Cost of 24,290 envelopes @ $2.00 per 1,000	48.58
Sealing envelopes with machine	2.00
Putting stamps on envelopes with machine, 15,000 per day	5.30
Postage on 4,536 receipts for checks received by mail	90.72
Putting reciepts in envelopes, 3/4 day	2.46
Cost of 4,536 envelopes @ $2.00 per M.	9.07
Sealing envelopes	.37
Putting stamps on envelopes, 3-10 days	.98
Cost to consumer for mailing, if we assume that the cost to consumer for envelopes and time in sealing and putting on stamps is double that of the city, we would have:	
Stamps	90.72
Time and envelopes	25.62
Making a total monthly cost of	$777.97

An inspection of the above statement will show that the actual cost to the city per month of mailing the 29,014 accounts and returning the receipts is $661.63. The actual cost to the consumers for postage in mailing checks, plus cost of envelopes and time is $116.34.

It will be noticed that the number of users who pay by mail remittance is small as compared with the number of those who pay at the counter, so that users would save far less in postage and envelopes by having collectors call at their houses than might be supposed.

As to the number of accounts that one man could collect, I estimate as follows:

Allowing a man fifteen minutes to go from the office to his work, and three-fourths of an hour to come from his work to the office and check up his cash each evening, which he would have to do before the treasurer's office closed at five p. m., his working time would be seven hours a day. This is doubtless a high estimate of the hours that he could spend in the field. Taking into account the time lost in ringing door bells and waiting for admission, the time lost when people were not at home, the time lost in hunting them up at their offices and elsewhere, and the inevitable discussions and arguments about the amount of the bills, I estimate that six minutes would on the average be consumed for each bill collected. This would be ten collections per hour or 70 per day or 1,820 per month per man, requiring the time of sixteen men at $75 per month, or a total of $1,200. Add car fare $2.50 per month, and cost of bonds say $1.50 per month, and we have a total of $1,264 against a present cost of $777.97, a difference in favor of the present system of $486.03 per month or $5,832.36 per year.

If, under the personal collection system, only a few accounts were paid at the office the cashier might handle the work now done by the receipt clerk, thus saving the salary of one man. This would reduce the cost $1,080 per year, still leaving a balance in favor of the present system of $4,752.36 per annum.

As to the plan of sending the water and lighting bills in the same envelope so that one envelope and stamp would transmit, and one envelope and stamp answer for a return check a thorough investigation of this plan was made in December, 1912, resulting as follows:

Of the 21,177 Lighting Department accounts, compared by location with the same premises in the Water Department, we find 8,182 or 38.6

per cent of the mailing list to be the same; that is, going to the same address, from both departments.

The postage on these 8,182 accounts at two cents each, would be $163.64, the cost of envelopes $11.86, making a total of $175, which, at the time of the investigation, would be the limit of the amount that could be saved on postage, by transmitting these bills together.

The adoption of the plan, however, would lead to other expenses, which would, I think, more than off-set the saving made. In order to set forth the actual workings of the plan suggested I find it will be necessary to go pretty well into the details of the process by which these bills are prepared and mailed to consumers. The methods by which they are handled by the Water and Light Departments are different. In both departments the readings are taken and entered on the meter reader's books in the order of the street numbers, corresponding to the location of the meters. The bills are then made out from the meter reader's books by the bill clerks and assorted numerically, so that when handed to the register clerks, who keep the books of account with each consumer, they will be in numerical order and can be entered expeditiously, because the account numbers in the books run consecutively. In the Water Department the account numbers correspond with the meter numbers, while in the Light Department, an arbitary account number is used.

In order to carry out the plan it would be necessary for the clerks in the Lighting Department to sort out from the 21,000 accounts the 8,000 bills which could be transmitted to the Water Department, for enclosure with their bills each month. These bills would come to us arranged in the order in which they were entered upon the Lighting Department register. It would then be necessary to re-distribute these lighting bills in accordance with the corresponding locations on the Water Department bills.

For purposes of reading and mailing, the city is divided into three districts. These districts, so far as the meter rates are concerned, are identical in both departments; District No. 1 extending from the south end of the city to Yesler Way, District No. 2 extending from Yesler Way, north to the canal, and District No. 3 including all the city north of the canal. The above processes, would, therefore, have to be gone through three times every month, as the district bills would be mailed from both departments once every ten days.

At the present time the bills for each day are made up from the reading books of the previous day, so that the clerks can be kept continuously at work and keep up with the meter readers. Some bills are now mailed each day, but in general there are but two mailings during each ten days. Under the plan proposed bills could not be mailed the morning after they were entered upon the register, but would have to be held until the corresponding bills were made out and delivered to the Water Department from the Lighting Department. This would undoubtedly cause a great deal of friction and annoyance, as well as loss of time.

While there is no way of determining the exact amount of labor that would be required to carry out all these processes, except by actual trial, it seems probable that it would more than off-set any savings that could be made in stamps and envelopes.

There are other matters in connection with this proposition which it is proper at this time to explain. The bills of the fixed rate districts are mailed on the first of each month. For example: The bills for the first quarter of the year for the first fixed rate district are mailed on the 1st of January, the bills for the quarter ending April 30th, being those for the second fixed rate district, are mailed on the 1st of February, and the bills for the quarter ending May 31st, being the third fixed rate district, are mailed on the 1st of March. Inasmuch as the bills for the first meter district are mailed on the 1st of January, those for the second meter district on the 10th, and those for the third meter district on the 20th, it will be noticed that the fixed rate bills will go out every month only with the meter bills for the first district. It will be seen, therefore, that so far as the fixed rate bills in the second and third fixed rate districts are concerned they can not go with the meter bills in the second and third meter rate districts. Therefore, no fixed rate bills in any district could be mailed with the meter rate bills in the second and third districts. See mailing statement on page 256.

The small amount, probably not to exceed $12 or $15 that could be saved by mailing the fixed rate bills with the lighting bills, is not a very important matter, even if we leave out of account the extra labor required to do the work.

An additional source of labor and expense would be occasioned by keeping a record of all cut-ins and cut-outs in the Water and Light departments, and comparing them one with another. In apartment houses it is the general practice to charge the occupant of each apartment with

his lighting bill, the department securing itself by requiring deposit from the tenant. In the case of the Water Department there is almost invariably a single charge, and that is against the owner of the building, to whom the bill is sent. As a result of this the number of addresses requiring to be changed every month in the Lighting Department is greater than those requiring to be changed in the Water Department even though the number of accounts in the Lighting Department is little more than one-half of those in the Water Department. The coming and going of tenants in rented houses and apartments requires a change of address in the Lighting Department. Wherever a change of this kind took place, the Water Department would have knowledge of it only by receiving the bill for such premises from the Lighting Department for mailing. On the other hand, when a new lighting service was cut-in, reference would have to be made to the corresponding location in the Water Department records to ascertain if the bill could be enclosed in the Water Department envelope. In the case of a changeof address for a water bill, notice would have to be sent to the Lighting Department to discontinue transmitting bills for that location to the Water Department.

In the case of a new water service the Lighting Department books would have to be consulted to see if the two bills could be sent to the same address.

As these new accounts and changes aggregate about 2,500 per month for both departments, the work of watching and correcting them would be very great.

There are considerable portions of the city covered by private water systems, as for instance, the greater part of Georgetown and West Seattle, where the Water Department sends no bills, and these districts are very largely covered by the City Lighting Department.

Again it is quite unusual for Lighting bills to be paid by or through a rental agency, while it is very common in the case of Water bills.

Again the private lighting companies cover probably one-half of the city, and, of course, the Water bills in such cases could not be mailed with the Light bills.

The Water Department is now saving in postage about $100 per month by assembling bills which go to one address, and by making special lists for the schools, rental agencies, etc., where there would be fifty or one hundred envelopes and stamps required if not so assembled.

In view of the above considerations, it is my judgment that the extra labor imposed, would far exceed the small amount saved in postage, by adopting the plan suggested, to say nothing of the confusion and delays that such a system would inevitably give rise to.

DATES OF MAILING WATER BILLS

	First District		Second District		Third District	
	Fixed Rates	Meter Rates	Fixed Rates	Meter Rates	Fixed Rates	Meter Rates
January	First	First	....	Tenth	....	Twentieth
February	....	"	First	"	....	"
March	....	"	....	"	First	"
April	First	"	....	"	....	"
May	....	"	First	"	....	"
June	....	"	....	"	First	"
July	First	"	....	"	....	"
August	....	"	First	"	....	"
September	....	"	....	"	First	"
October	First	"	....	"	....	"
November	....	"	First	"	....	"
December	....	"	....	"	First	"

As to the reading of meters in the Water and Light departments by the same man, the time consumed in the aggregate under such a system would be more rather than less. Instead of consulting one book in passing from one premises to another the reader would have to consult two, which would consume additional time. The truth is that where meters are close together the time lost in walking from one meter to another is of little consequence. The Water Department meters are outside of houses and can be read without delay. If they had to be read at the same time as the electric meters it would take much longer as the electric meters are in the houses, very frequently in the bath rooms, and are not always accessible when the meter reader calls. The delay manifests itself very clearly in the cost of reading, the Lighting Department requiring six readers for 33,000 meters while the Water Department uses only four readers for 35,000 meters.

The matter of reading the meters and rendering bills every three months instead of every month is discussed in the department report to the Council on the Emerson efficiency investigation and need not be repeated here.

Volunteer Park Reservoir

Lincoln Park Reservoir

Complaints of Excessive Consumption of Water

Few people realize how reliable the registration of water by meter has become through improvements in the materials and designs of meters. Failure to register within two per cent of the exact amount that passes through a meter is rare in the case of the best makes, except where they happen to become clogged with sand, calking yarn, leaves or some other obstruction. In all such cases, however, the registration drops, so that the consumer gets the benefit. Numerous tests made by the department, and extending over a number of years, show that where meters over-register any considerable amount in one case, they under-register in hundreds of cases. The reason of this should be clear. Before a meter leaves the shop to go into commission it is tested, and the gearing adjusted so that it registers right. New meters are almost invariably right, but they are tested before installation to make assurance doubly sure. However, meters that have been used and returned to the shop are liable to under-register, and must be tested before being sent out again. Besides being often clogged with obstructions, their parts, after long use, are more or less worn and they under-register by loose motion.

The only motive power driving the wheels is the water that passes through the meter, and when it slackens its motion the wheels slacken also. If there is lost motion from wear, so that water gets through without turning the wheels, the water is not fully registered and the consumer gets the benefit. For this reason many people who think they are overcharged, and want a new meter, have to pay more when the new meter goes in. It may be set down almost as a maxim that both the mechanism of a meter and the conditions under which it works tend to obstruct rather than accelerate the registration.

The following tables show the results of meter tests requested by consumers during the years 1910, 1911 and 1912:

RESULT OF TESTS ON WATER METERS

Test Number	Date Tested	Per Cent Reg.	Per Cent Favor of Consumer	Per Cent Favor of City
		1910		
1	Feb. 2	98.2	1.8	
2	Feb. 2	100.		
3	Feb. 10	100.		
4	Feb. 15	100.		
5	Feb. 21	97.5	2.5	
6	Mch. 4	103.2		3.2
7	Mch. 12	100.		
8	Mch. 26	99.5	.5	
9	April 6	99.	1.	
10	April 9	101.5		1.5
11	April 13	100.		
12	May 10	100.		
13	May 16	100.		
14	May 20	99.5	.5	
15 Cancelled				
16 Cancelled				
17	June 28	100.		
18	July 2	99.	1.	
19	July 22	98.5	.5	
20	Aug. 3	100.		
21	Aug. 6	100.		
22	Aug. 8	99.5	.5	
23	Aug. 10	100.		
24	Aug. 11	100.		
25	Aug. 15	100.		
26	Aug. 16	99.5	.5	
27	Aug. 26	100.		
28	Sept. 2	100.		
29	Sept. 9	99.5	.5	
30 Cancelled				
31	Sept. 14	100.		
32	Sept. 16	100.		
33	Sept. 21	99.5	.5	
34	Sept. 22	97.5	2.5	
35	Oct. 8	100.		
36	Nov. 4	100.		
37	Dec. 30	100.		
38	Dec. 1	99.5	.5	
39	Dec. 7	100.		
40	Dec. 10	102.		2.
41	Dec. 29	100.		
		1911		
42	Jan. 21	100.		
43	Feb. 14	99.5	.5	
44	Feb. 14	100.		
45	Feb. 15	99.5	.5	
46	Feb. 28	100.		
47	Feb. 28	99.5	.5	
48	Mch. 9	95.	5.	
49	Mch. 13	100.		
50 Cancelled				

RESULT OF TESTS ON WATER METERS

Test Number	Date Tested	Per Cent Reg.	Per Cent Favor of Consumer	Per Cent Favor of City
		1911 Continued		
51	Mch. 30	100.		
52	May 1	99.5	.5	
53	May 15	91.	9.	
54	May 27	99.	1.	
55	June 6	98.	2.	
56	June 10	99.5	.5	
57	June 10	100.		
58	June 19	99.	1.	
59	July 14	88.	12.	
60	Aug. 3	100.		
61	Aug. 22	99.5	.5	
62	Aug. 30	99.5	.5	
63	Sept. 7	96.5	3.5	
64	Sept. 11	100.		
65	Sept. 14	99.5	.5	
66	Sept. 16	99.5	.5	
67	Sept. 18	100.		
68	Sept. 18	101.5		1.5
69	Oct. 3	99.	1.	
70	Nov. 8	98.	2.	
71	Nov. 13	99.5	.5	
72	Nov. 27	99.5	.5	
73	Dec. 16	98.5	1.5	
74	Dec. 23	101.		1.
		1912		
75	Jan. 5	98.	2.	
76	Jan. 12	100.		
77	Jan. 29	101.5		1.5
78 Cancelled				
79 Cancelled				
80	April 12	94.5	5.5	
81	May 20	99.5	.5	
82 Cancelled				
83	July 2	99.5	.5	
84	July 3	99.	1.	
85	July 15	99.5	.5	
86	Aug. 1	97.	3.	
87	July 31	100.		
88	Aug. 2	100.		
89	Aug. 8	99.5	.5	
90	Aug. 13	99.5	.5	
91	Aug. 15	99.5	.5	
92	Aug. 17	97.5	2.5	
93	Sept. 3	99.	1.	
94 Cancelled				
95	Oct. 14	100.5		.5
96	Oct. 16	100.		
97	Oct. 21	100.		
98	Oct. 21	101.5		1.5
99	Oct. 29	99.	1.	
100 Cancelled				

WASTE OF WATER THROUGH LEAKAGE IN FIXTURES

It is proper to present in this report for the information of those who have never investigated the matter, a table showing the amount of water that will be wasted through openings of various sizes and under various heads or pressures. It will doubtless surprise many people to discover the large quantity of water that can thus escape through leaky pipes or fixtures. By multiplying any amount given in the tables by 30, the quantity of flow for a full month can be ascertained and the cost of same determined by computing it at the rates established by ordinance. The figures are ten per cent below the theoretical discharge.

DISCHARGE IN CUBIC FEET PER 24 HOURS

Pressure in Pounds per Square Inch

Diameter of Opening	10	20	30	40	50	60	70	80	90	100	110	120	130
1/32"	16	23	28	33	36	40	44	46	49	51	54	57	59
1/16"	65	92	113	130	146	160	172	184	195	207	216	225	235
1/8"	261	369	452	521	584	640	691	737	783	824	865	903	947
1/4"	1043	1480	1800	2080	2333	2550	2750	2950	3133	3293	3453	3800	3760
1/2"	4160	5890	7230	8310	9290	10190	10990	11760	12450	13150	13770	14390	14970
3/4"	9350	13280	16250	18760	20970	23000	24830	27440	28100	29700	31090	32510	33810
1"	16650	23570	28890	33350	37280	40880	44150	47160	50050	52720	55250	57710	60110
2"	66650	94200	115430	133330	148900	163500	176400	188500	200000	210800	221100	230000	240300
4"	266700	373300	462700	533300	596000	653300	705300	755800	900000	842700	884000	924000	961300
6"	500000	849300	1040000	1200000	1346700	1466700	1586700	1698700	1800000	1900000	1986700	2080000	2160000

DISCHARGE IN GALLONS PER 24 HOURS

Pressure in Pounds per Square Inch

Diameter of Opening	10	20	30	40	50	60	70	30	90	100	110	120	130
1/32"	122	173	213	213	274	300	333	347	367	386	406	424	442
1/16"	488	690	846	976	1095	1200	1290	1330	1460	1550	1620	1690	1760
1/8"	1960	2770	3390	3910	4380	4800	5180	5530	5870	6180	6490	6770	7100
1/4"	7820	11100	13500	15800	17500	19100	20700	22100	23500	24700	25900	27000	28200
1/2"	31200	44200	54200	62300	69700	76400	82400	88200	93400	98600	103300	107900	112300
3/4"	70400	99600	121900	14070	157300	172500	186200	205800	211800	211000	222500	243800	253600
1"	124900	176800	216700	250100	279600	306600	331100	353700	375400	395400	414400	432800	450800
2"	499900	706500	865700	1600000	1117000	1226000	1323000	1414000	1600000	1581600	1658000	1732000	1802000
4"	2000000	2800000	3470000	4000000	4470000	4900000	5290000	6560000	6000000	6320000	6630000	6930000	7210000
6"	4900000	6370000	7900000	6000000	10100000	11000000	11900000	12700400	13900000	14250000	14900000	15600000	16200000

TAPS, METERS, HYDRANTS AND GATES INSTALLED UP TO JANUARY 1, 1914

Taps		Meters		Gates		Hydrants	
Size	No.	Size	No.	Size	No.	Size	No.
½"	13798	½"	11431	2"	955	6"	5078
¾"	26407	¾"	20877	2½"	12	8"	265
1"	1621	1"	1202	3"	19		
1½"	281	1½"	195	4"	209		
2"	825	2"	576	5"	6		
3"	141	3"	148	6"	531		
4"	217	4"	116	8"	2403		
6"	149	6"	76	10"	149		
8"	8	8"	2	12"	571		
				16"	105		
				18"	13		
				20"	96		
				24"	55		
				30"	14		
				36"	1		
				42"	1		
Totals..	43447		34623		5140		5343
Air valves					56		

NUMBER OF WATER ACCOUNTS ON BOOKS

December 31, 1913

Fixed rates	5,225
Meter rates	34,623

NUMBER OF WATER TAPS ON JANUARY 1 OF EACH YEAR

1891	710	1903	7,825
1892	1,637	1904	10,236
1893	2,269	1905	12,655
1894	2,606	1906	15,055
1895	2,816	1907	17,444
1896	3,408	1908	22,132
1897	3,236	1909	24,315
1898	3,451	1910	31,839
1899	3,798	1911	36,010
1900	4,313	1912	39,013
1901	5,125	1913	40,163
1902	6,255	1914	43,447

NUMBER AND SIZE OF WATER METERS IN USE FROM JANUARY 1, 1897, TO JANUARY 1, 1914

	½ Inch	¾ Inch	1 Inch	1½ Inch	2 Inch	3 Inch	4 Inch	6 Inch	8 Inch	12 Inch	Total Installed	Total In use
In use Jan. 1, 1897	85	169	68	11	47	10	8	2				400
Installed 1897	43	33	2	4	9		7				98	
In use Jan. 1, 1898	128	202	70	15	56	10	15	2				498
Installed 1898	54	48	1		13	3	-1				118	
In use Jan. 1, 1899	182	250	71	15	69	13	14	2				616
Installed 1899	23	22	13		15	6		1			80	
In use Jan. 1, 1900	205	272	84	15	84	19	14	3				696
Installed 1900	27	33	15	-2	5	8	2	-1			87	
In use Jan. 1, 1901	232	305	99	13	89	27	16	2				783
Installed 1901	53	84	5	-1	17	7	3	2			170	
In use Jan. 1, 1902	285	389	104	12	106	34	19	4				953
Installed 1902	47	25	3	4	22	6		4			111	
In use Jan. 1, 1903	332	414	107	16	128	40	19	8				1,064
Installed 1903	59	38	2	1	4	3	7	2	1		117	
In use Jan. 1, 1904	391	452	109	17	132	43	26	10	1			1,181
Installed 1904	27	122	33	13	8	1	8	1	1		214	
In use Jan. 1, 1905	418	574	142	30	140	44	34	11	2			1,395
Installed 1905	44	75	17		17	7	5	-1			164	
In use Jan. 1, 1906	462	649	159	30	157	51	39	10	2			1,559
Installed 1906	127	193	33	1	12	10	6	5			387	
In use Jan. 1, 1907	589	842	192	31	169	61	45	15	2			1,946
Installed 1907	398	1,216	135	11	49	12	25	13	1		1,860	
In use Jan. 1, 1908	987	2,058	327	42	218	73	70	28	3			3,806
Installed 1908	1,135	2,603	180	27	65	19	14	16	1		4,060	
In use Jan. 1, 1909	2,122	4,661	507	69	283	92	84	44	4			7,866
Installed 1909	1,676	3,609	192	35	37	14	12	13	2		5,590	
In use Jan. 1, 1910	3,798	8,270	699	104	320	106	96	57	6			13,456
Installed 1910	3,124	4,694	217	56	91	20	6	6	-5	1	8,210	
In use Jan. 1, 1911	6.922	12,964	916	160	411	126	102	63	1	1		21,666
Installed 1911	1,936	4,353	169	-3	111	14	5	8	1	-1	6,593	
In use Jan. 1, 1912	8,858	17,317	1,085	157	522	140	107	71	2			28,259
Installed 1912	1,449	2,057	84	19	18	8	-2	-2			3,631	
In use Jan. 1, 1913	10,307	19,374	1,169	176	540	148	105	69	2			31,890
Installed 1913	1,124	1,503	33	19	36		11	7			2,733	
In use Jan. 1, 1914	11,431	20,877	1,202	195	576	148	116	76	2			34,623

-Minus numbers are meters removed.

DISTRIBUTING MAINS IN THE WATER SYSTEM ON JANUARY 1, 1914.

		Lin Ft.
2"		394,694
3"	(Wood and iron)	37,985
4"	Cast iron	25,191
	Wood	73,500
6"	Cast iron	229,870
	Wood	178,479
8"	Cast iron	1,122,281
	Wood	297,221
10"	Cast iron	58,055
	Wood	43,072
	Steel	1,614
12"	Cast iron	225,540
	Wood	20,917
	Kalamein	26,086
16"	Cast iron	37,951
	Wood	31,659
	Kalamein	2,466
18"	Wood	17,472
20"	Cast iron	96,351
	Wood	18,079
24"	Cast iron	28,416
	Steel	4,865
30"	Cast iron	31,093
	Steel	664
32"	Steel	10,680
36"	Steel	4,307
	Wood	4,432
42"	Steel	667
	Total in Feet	3,023,607
	Total in Miles	572.65

The above does not include the 62.61 miles of supply mains from Cedar River.

LINCOLN PARK PUMPING STATION
MONTHLY REPORT OF GALLONS PUMPED, 1913

	Gould Triplex No. 1	Gould Triplex No. 2	Total
January	40,503,987.5	45,006,516.5	85,510,504.
February	36,065,141.5	41,726,142.	77,791,283.5
March	38,812,008.	42,661,934.	81,473,942.
April	40,420,609.5	43,500,383.	83,920,992.5
May	45,316,035.5	45,822,794.5	91,138,830.
June	45,372,070.	45,435,322.	90,807,392.
July	47,285,633.5	47,442,242.5	94,727,876.
August	47,334,144.	47,439,146.	94,773,290.
September	45,687,743.	45,733,447.5	91,421,190.5
October	45,166,023.5	45,795,312.5	90,961,336.
November	44,101,638.5	43,570,746.	87,672,384.5
December	45,153,989.	44,621,678.5	89,775,667.5
	521,219,023.5	538,755,665.	1,059,974,688.5

The Accounting System

The assertion is frequently made that systems of accounting in vogue in municipal corporations do not give a satisfactory or lucid statement of the financial condition of same. This criticism may have been warranted to a larger degree in former years. The functions of municipal government during the last decade have been measurably broadened and cities today not only perform the primary functions of protecting the life and property of inhabitants but are engaged in large business enterprises of their own such as furnishing water, light and power and transportation facilities to citizens. It is therefore of paramount importance that a strict accounting be had in order to determine the relative cost at which each service is supplied to the citizens or stock holders of the municipal corporation.

The City of Seattle has realized the importance of this subject and during the years 1907-1908 employed the world wide known firm of chartered accountants, Price Waterhouse and Company, to install a complete system of municipal accounting. It is the purpose of this article to deal particularly with this subject as it affects the operations of the municipal water supply system.

Prior to 1908 only a very meager record of the financial transactions of this large public utility was available, confined practically to a record of the cash receipts and disbursements as affecting this utility. In the spring of 1908 a comprehensive set of accounts was introduced and at the same time the city began the innovation of mailing statements of account to each individual customer, something that had not previously been done excepting in the case of the few metered accounts at that time in existence.

A "revenue and expense" system of accounts was installed. All earnings of whatever nature being credited to each special revenue account such as Metered Water to Metered Water Revenue, Fixed Rates to Fixed Rates Revenue and Miscellaneous Water to Miscellanous Water Revenue. Further revenue accounts were opened for services connected (Taps Connected) Revenue, Sale of Material and Labor (Domestic Service) Revenue and sundry other revenues requiring specific designation.

A controlling account in the General Ledger was opened up for all Metered Water, Flat Rate and Miscellaneous accounts, these being charged with all services rendered and credited with all payments made. A complete set of Operating and Maintenance accounts were also intro-

duced whereby the most minute expense of operating and maintaining Headworks, Pipe Lines, Stand Pipes, Reservoirs, Pumping Stations, Mains and Hydrants, Domestic Service, Office and General Expense, Reconstruction and sundry other accounts could be ascertained. At the end of the year all revenue accounts and all operation and maintenance and reconstruction accounts are closed into the revenue and expense accounts and after interest charges and depreciation are provided for, the balance becomes a revenue surplus for the year.

Provision has also been made for a complete record of all capital expenditures (construction) paid out of revenues of the plant. A synopsis or summary of the records and transactions of the department is forwarded to the City Comptroller at the end of each fiscal year and is embodied in his records which cover the entire range of municipal activities.

All current expenses are paid by warrants drawn by the City Comptroller on vouchers issued and duly authenticated by the Water Department. This applies, however, only to such transactions as affect the water fund. As the department ultimately is expected to and does take care of all the bonded obligations incurred in extending the water system it would be well to have all vouchers for capital expenditures derived from the sale of water bonds similarily vouchered and authenticated by the Water Department before a warrant issues. This is not being done at the present time but if this change could be made the department would have a complete set of accounts, not only of income and outgo of current revenues but also of capital expenditures. The amounts paid by the private property for the installation of water mains (Local Improvement Assessments) is annually set up as a capital liability and plant account debited with sums so contributed.

SCHEDULE OF ACCOUNTS

ASSET AND LIABILITY ACCOUNTS

Real Estate
Construction
- Cedar River Water Supply No. 1
  - Pipe Lines and Reservoirs
  - Miscellaneous Charges
- Cedar River Water Supply No. 2
  - Pipe lines
  - Beacon Hill Reservoir
  - Green Lake Intermedite Service Reservoir
  - Green Lake Low Service Reservoir

ASSET AND LIABILITY ACCOUNTS—(Continued)

- Green Lake Overflow
- Hubbell Way main
- Lake Union Trestle
- Volunteer Park Overflow
- Settling Basin (Headworks)
- Lake Union 36-inch Main
- Harvard Avenue Mains
- Green Lake Supply Mains
- Magnolia Bluff Tower
- Interbay Pump Station
- Pipe Line Betterment
- Headworks Betterment

Distribution Mains
- Mains paid for by Private Property
- Mains paid for by Bond Funds
- Mains paid for out of Current Revenues

Old Systems Acquired
- Spring Hill Plant
- Lake Union Plant
- Ballard Water System
- Columbia Water System
- Fairmount Water System
- Georgetown Water System
- Homeseekers Water System
- Rainier Valley Water System

Pumping Stations
Standpipes
Meters in Use
Installation Meters
Taps Connected
Latona Tunnel

Material (Inventory)
Material Fremont Station (Inventory)
Tools (Inventory)
Automobiles (Inventory)
Sundry Debtors—Metered Water
Sundry Debtors—Fixed Rates
Sundry Debtors—Sundry Sales
City of Seattle—(General Fund)
City Treasurer—Guaranty Deposits
Accounts Payable
General Fund
Blacksmith Shops
Comptroller's Current Account

ASSET AND LIABILITY ACCOUNTS—(Continued)

Horse Harness and Wagon (Inventory)
Store Expense (Inventory)
Office (Inventory)
Headworks (Inventory)
Pipe Line (Inventory)
Stables (Inventory)
Pump Stations (Inventory)
Suspense Accounts
Warrants and Bonds Payable
Fund Accounts

REVENUE AND EXPENSE ACCOUNTS

Watershed
- (a) Fire Patrol
- (b) Building Trails

Headworks
- (a) Settling Basin
- (b) Buildings (repairs)
- (c) Sundry Items

Pipe Lines:	No. 1	(a) Operating
		(b) Maintenance
Pipe Lines:	No. 2	(a) Operating
		(b) Maintenance
Reservoirs:	Volunteer Park	(a) Operating
		(b) Maintenance
	Lincoln Park	(a) Operating
		(b) Maintenance
	Green Lake	(a) Operating
		(b) Maintenance
	Maple Leaf	(a) Operating
		(b) Maintenance
	Beacon Hill	(a) Operating
		(b) Maintenance
Pumping Stations:	Lincoln Park	(a) Operating
		(b) Maintenance
	Lake Washington	(a) Operating
		(b) Maintenance
	Ballard	(a) Operating
		(b) Maintenance
	Queen Anne	(a) Operating
		(b) Maintenance
	Volunteer Park	(a) Operating
		(b) Maintenance

REVENUE AND EXPENSE ACCOUNTS—(Continued)

Interbay	(a) Operating	
	(b) Maintenance	
West Seattle	(a) Operating	
	(b) Maintenance	
Kenyon Street	(a) Operating	
	(b) Maintenance	

Mains and Hydrants
- (a) Mains—Operating
- (b) Mains—Maintenance
- (c) Hydrants—Operating
- (d) Hydrants—Maintenance
- (e) Gates—Operating
- (f) Gates—Maintenance

Meters
- (a) Operating
- (b) Maintenance

Domestic Service
- (a) Operating
- (b) Maintenance

Store Expense—Operating
Shop Expense—Operating
*Stables—Operating (Redistributed)
*Blacksmith Shop—Operating (Redistributed)
*Automobiles 1-7 (a) Operating
(b) Maintenance
*Auto Trucks 1-9 (a) Operating
(b) Maintenance
*Tools—Operating (Redistributed)
*Horse, Harness and Wagon (Redistributed)

Office and General Expense—Operating
- (a) General
- (b) Accounting
- (c) Inspection
- (d) Technical
- (e) Treasurer
- (f) Comptroller
- (g) Books and Stationery
- (h) Postage
- (i) Vacations (General Expense)
- (j) Miscellaneous
- (k) Furniture and Fixtures

Free Service—Operating

* After inventory is taken balance is redistributed.

REVENUE AND EXPENSE ACCOUNTS—(Continued)

Lost Accounts—Operating
Exchange—Operating
Interest—Operating
Reconstruction
- (a) Mains
- (b) Hydrants
- (c) Taps
- (d) Meters

Metered Water Revenue
Fixed Rates Revenue
Miscellaneous Water Revenue
Miscellaneous Revenue
Tapping Connections Revenue
Domestic Service Revenue
Shut-off Revenue
Penalties Revenue
Blacksmith Shop Revenue
Municipal Service Revenue
Rebates—Metered Water Revenue
Rebates—Fixed Rates Revenue
Rebates—Miscellaneous Water Revenue
Rebates—Domestic Service Revenue
Revenue and Expense

METERED WATER CONSUMPTION, 1913

	Amt. Consumed cu. ft.	Revenue	Average Price Per 100 cu. ft.
January	67,555,444	$48,152.45	.0712
February	66,948,437	48,480.43	.0722
March	67,122.372	47,889.78	.0713
April	73,966,151	51,726.48	.0687
May	75,504,490	52,865.80	.07
June	79,853,028	56,520.69	.0707
July	82,253,736	56,736.42	.0689
August	102,743,248	67,426.75	.0656
September	104,845,637	67,425.63	.0643
October	88,894,745	59,829.08	.0673
November	80,508,380	55,338.55	.0674
December	75,245,773	54,046.90	.0718
	965,442,441	$666,438.96	.0692

965,442.441 × 7.5 = 7,240,818,307½ gallons.
7,240,818,307 ÷ 365 = 19,837,858 gallons per day.

Assuming that the City of Seattle has a population of 300,000 and that our 5,000 Fixed Rate Accounts represent 25,000 population, we therefore have 275,000 of population consuming 19,837,858 gallons per day.

PER CAPITA CONSUMPTION OF METERED WATER

19,837,858 ÷ 275,000 = 72.13 gallons per day, per capita.

LOCAL IMPROVEMENT DISTRICT MAINS PAID BY PROPERTY IN 1913

Ord.	L. I. D.	Location	Property
21722	2163	21st Ave. So. et al.	$ 29,802.99
27363	2498	Brandon St. et al.	336.28
29034	2522	42d. Ave. So.	652.35
29385	2527	Whatcom Ave. et al.	4,222.70
29385	2527	Whatcom Ave. Supp.	242.59
29197	2525	Genesee St. et al.	2,143.00
29411	2529	24th Ave. and 24th Ave. No.	1,675.58
29588	2548	37th Ave. No. et al.	1,353.35
29613	2550	Jackson St. et al.	2,222.80
29674	2556	Charles St. et al.	669.62
29641	2554	14th Ave. N. E.	3,940.19
29886	2567	31st Ave. So. et al.	582.02
30059	2580	Bigelow Ave. and Queen Anne Blvd.	5,202.23
30060	2581	East Prospect St. et al.	2,126.26
30069	2583	East 82d St.	2,802.45
30104	2584	Bella Vista Ave. et al.	2,465.55
30105	2585	Shoreland Drive et al	904.52
30212	2588	Dawson St.	3,370.74
30003	2573	5th Ave. et al	7,293.22
30279	2597	Fremont Ave.	6,083.21
30243	2589	Third Ave. N. W.	181,863.19*
30390	2602	Commodore Way	3,406.88
30433	2604	East 60th St. et al	19,775.73
30436	2607	Ravenna Blvd.	3,747.52
30437	2608	Leary Ave. et al	2,591.30
30531	2613	12th Ave. So. et. al.	1,262.28
30586	2619	North 50th St.	13,281.35
30665	2620	10th Ave. W. et al.	8,990.00
30698	2624	Jackson St. et al.	182.20
30794	2628	West 63d St.	1,523.34
30760	2627	Bayview St. et al.	13,714.76
30941	2637	Pine St. et al.	6,191.93
30973	2638	East Howell St.	1,038.01
30974	2639	Grand Ave.	2,089.61
31034	2642	Mercer St.	2,064.23
31036	2644	Boyer Ave.	9,861.00
31037	2645	Sixth Ave. So.	10,959.32
31203	2652	Fifth Ave. N. E.	1,328.75
31205	2654	North 82d St. et al	6,406.00
31206	2655	West 61st St.	2,502.52
31113	2650	College St. et al	4,887.61
31378	2667	32d Ave. N. W.	1,392.89
31534	2675	Shoreland Drive	2,135.74
31558	2681	34th and 35th Ave. N.	7.92
31643	2694	Boren Ave. et al	30.00
			$379,325.73

* Assessed against property, but since charged against the water fund to the amount of $139,276.48 with interest. See page 179.

REVENUE AND EXPENSE, 1913

Watershed	$ 2,518.06	Metered Water	$662,735.92
Headworks	1,203.66	Fixed Rates	58,090.00
Pipe Lines	16,516.41	Miscellaneous Water	9,379.05
Reservoirs	5,859.89	Taps Connected	27,214.24
Pump Stations	15,181.56	Domestic Service	6,018.16
Standpipes	1,621.53	Miscellaneous	420.12
Mains and Hydrants	22,969.37	Blacksmith Shop	12,990.34
Meters	19,543.04	Penalties	81.00
Domestic Service	16,343.49	Shut-offs	1,499.00
Office and General Exp.	72,883.45	Municipal Service	94,000.00
Store Expense	4,975.62		
Shop Expense	1,730.25	Total Revenue	$872,427.83
Free Service	2,276.60	Cancelled Warrants	18.99
Lost Accounts	8.17	Adjustments	.01
Exchange	.70		
Blacksmith Shop	14,438.72		
Operation and Maint.	$198,070.52		
Reconstruction	20,737.55		
Interest	244,820.70		
	463,628.77		
Profit before Depreciation	408,818.06		
	$872,446.83		$872,446.83

Depreciation of Plant, 1913	195,115.34		
Net Profit for 1913	*213,702.72	To Balance	408,818.06
	$408,818.06		$408,818.06

* This $213,702.72 was used for the liquidation of the bonded and warrant indebtedness.

Operation	136,222.28	Total Revenue	$872,427.83
Maintenance	61,848.24		
Reconstruction	20,737.55		
Interest	244,820.70		
Total Operating Exp.	$463,628.77		
Bonds and Warrants Redeemed	235,566.40		
Construction paid out of Revenue	135,947.30		
Real Estate paid out of Revenue	1,007.98		
Balance being surplus of Revenue over all Exp.	36,277.38		
	$872,427.83		$872,427.83

CONTRIBUTIONS TO LOCAL IMPROVEMENT FUNDS BY THE WATER FUND IN 1913

January	$ 1,105.44
February	4,725.50
March	6,270.35
April	4,408.26
May	4,492.00
June	3,202.97
July	2,055.97
August	8,211.52
September	....
October	15,852.08
November	3,086.30
December	25,960.42
	$79,370.81
L. I. D. Contributions, 1911	$80,185.36
L. I. D. Contributions, 1912	80,652.65

The above amounts were withdrawn from earnings of plant by ordinances during 1913, but not provided for in the Annual Budget for that year. Similar withdrawals have been made every year, sometimes running to sums much more than $80,000.

CONSTRUCTION OUT OF REVENUE DURING 1913

Hydrants	$ 143.78	
Headworks	488.79	
Installation Meters	9,069.88	
Meters in Use	28,422.62	
Mains, L. I. D.	57,999.09	
Twelfth Avenue South Tunnel	17,671.48	
Pipe Line Betterment	1,438.51	
Taps Connected	23,452.37	
		$138,686.52
Less Credit on Mains taken out		2,739.22
		$135,947.30

TOTAL RECEIPTS FROM ALL SOURCES—EXCEPT SALE OF BONDS—1899 TO 1913 INCLUSIVE

	Receipts	Transfers	Total
1899	$163,084.77	....	$163,084.77
1900	201,345.26	....	201,345.26
1901	232,757.87	....	232,757.87
1902	304,687.82	....	304,687.82
1903	396,332.64	....	396,332.64
1904	436,557.75	....	436,557.75
1905	487,787.76	....	487,787.76
1906	530,674.35	....	530,674.35
1907	648,067.77	....	648,067.77
1908	681,240.07	....	681,240.07
1909	738,967.15	$188,908.96	927,876.11
1910	761,940.65	167,355.40	929,296.05
1911	817,077.81	78,237.60	895,315.41
1912	855,523.78	....	855,523.78
1913	866,404.91	....	866,404.91

CEDAR RIVER WATER SUPPLY NO. 1 WARRANTS

Rate of Interest, 5 per cent

Interest and Redemption When Payable.

	Amount Due	Redemption Payments	Interest Payments	Total Payments
Original issue....	$1,250,000			
July 1, 1902........	1,231,000	$ 19,000	$ 31,250	$ 50,250
Dec. 31, 1902........	1,212,000	19,000	30,775	49,775
July 1, 1903........	1,192,000	20,000	30,300	50,300
Dec. 31, 1903........	1,122,000	70,000	29,800	99,800
July 1, 1904........	1,100,000	22,000	28,050	50,050
Dec. 31, 1904........	1,050,000	50,000	27,500	77,500
July 1, 1905........	1,026,000	24,000	26,250	50,250
Dec. 31, 1905........	1,000,000	26,000	25,650	51,650
July 1, 1906........	975,000	25,000	25,000	50,000
Dec. 31, 1906........	949,000	26,000	24,375	50,375
July 1, 1907........	922,000	27,000	23,725	50,725
Dec. 31, 1907........	895,000	27,000	23,050	50,050
July 1, 1908........	868,000	27,000	22,375	49,375
Dec. 31, 1908........	838,000	30,000	21,700	51,700
July 1, 1909........	808,000	30,000	21,013	51,013
Dec. 31, 1909........	779,000	29,000	20,261	49,261
July 1, 1910........	749,000	30,000	19,497	49,497
Dec. 31, 1910........	717,000	32,000	18,788	50,788
July 1, 1911........	685,000	32,000	17,947	49,947
Dec. 31, 1911........	652,000	33,000	17,125	50,125
July 1, 1912........	618,000	34,000	16,000	50,000
Dec. 31, 1912........	583,000	35,000	15,000	50,000
July 1, 1913........	$ 548,000	$ 35,000	$ 14,575	$ 49,575
Dec. 31, 1913........	512,000	36,000	13,700	49,700
July 1, 1914........	475,000	37,000	12,800	49,800
Dec. 31, 1914........	437,000	38,000	11,875	49,875
July 1, 1915........	398,000	39,000	10,925	49,925
Dec. 31, 1915........	358,000	40,000	9,950	49,950
July 1, 1916........	317,000	41,000	8,950	49,950
Dec. 31, 1916........	275,000	42,000	7,925	49,925
July 1, 1917........	232,000	43,000	6,875	49,875
Dec. 31, 1917........	188,000	44,000	5,800	49,800
July 1, 1918........	143,000	45,000	4,700	49,700
Dec. 31, 1918........	97,000	46,000	3,575	49,575
July 1, 1919........	49,000	48,000	2,425	50,425
Dec. 31, 1919........	....	49,000	1,225	50,225
		$1,250,000	$630,731	$1,880,731

CEDAR RIVER WATER SUPPLY NO. 2 BONDS

Cedar River Water Supply No. 2.—Statement of authorized payments on principal and interest until the bonds mature. Rate of interest, 5 per cent.

Date	Interest	Redemption	Total	Balance Due
Jan. 1, 1910.	$56,250.00	$87,000.00	$143,250.00	$2,163,000.00
July 1, 1910.	54,075.00	....	54,075.00	2,163,000.00
Jan. 1, 1911.	54,075.00	92,000.00	146,075.00	2,071,000.00
July 1, 1911.	51,775.00	....	51,775.00	2,071,000.00
Jan. 1, 1912.	51,775.00	96,000.00	147,775.00	1,975,000.00
July 1, 1912.	49,375.00	....	49,375.00	1,975,000.00
Jan. 1, 1913.	49,375.00	102,000.00	151,375.00	1,873,000.00
July 1, 1913.	46,825.00	....	46,825.00	1,873,000.00
Jan. 1, 1914.	46,825.00	106,000.00	152,825.00	1,767,000.00
July 1, 1914.	44,175.00	....	44,175.00	1,767,000.00
Jan. 1, 1915.	44,175.00	112,000.00	156,175.00	1,655,000.00
July 1, 1915.	41,375.00	....	41,375.00	1,655,000.00
Jan. 1, 1916.	41,375.00	117,000.00	158,375.00	1,538,000.00
July 1, 1916.	38,450.00	....	38,450.00	1,538,000.00
Jan. 1, 1917.	38,450.00	123,000.00	161,450.00	1,415,000.00
July 1, 1917.	35,375.00	....	35,375.00	1,415,000.00
Jan. 1, 1918.	35,375.00	129,000.00	164,375.00	1,286,000.00
July 1, 1918.	32,150.00	....	32,150.00	1,286,000.00
Jan. 1, 1919.	32,150.00	136,000.00	168,150.00	1,150,000.00
July 1, 1919.	28,750.00	....	28,750.00	1,150,000.00
Jan. 1, 1920.	28,750.00	142,000.00	170,750.00	1,008,000.00
July 1, 1920.	25,200.00	....	25,200.00	1,008,000.00
Jan. 1, 1921.	25,200.00	150,000.00	175,200.00	858,000.00
July 1, 1921.	21,450.00	....	21,450.00	858,000.00
Jan. 1, 1922.	21,450.00	157,000.00	178,450.00	701,000.00
July 1, 1922.	17,525.00	....	17,525.00	701,000.00
Jan. 1, 1923.	17,525.00	165,000.00	182,525.00	536,000.00
July 1, 1923.	13,400.00	....	13,400.00	536,000.00
Jan. 1, 1924.	13,400.00	173,000.00	186,400.00	363,000.00
July 1, 1924.	9,075.00	....	9,075.00	363,000.00
Jan. 1, 1925.	9,075.00	182,000.00	191,075.00	181,000.00
July 1, 1925.	4,525.00	....	4,525.00	181,000.00
Jan. 1, 1926.	4,525.00	181,000.00	185,525.00	....
Total.....	$1,083,250.00	$2,250,000.00	$3,333,250.00	....

SEATTLE REFUNDING BONDS "1910"

Statement of balance due on January 1, 1911, with schedule of annual payment of principal and semi-annual payment of interest until the bonds mature.

Date	Interest	Principal	Total	Balance Due
Jan. 1, 1911.	....	....	....	$823,764.40
July 1, 1911.	$20,594.11	$20,350.79	$40,944.90	803,413.61
Jan. 1, 1912.	20,085.34	....	20,085.34	803,413.61
July 1, 1912.	20,085.34	41,586.39	61,671.73	761,827.22
Jan. 1, 1913.	19,045.68	....	19,045.68	761,827.22
July 1, 1913.	19,045.68	41,586.39	60,632.07	720,240.83
Jan. 1, 1914.	18,006.02	....	18,006.02	720,240.83
July 1, 1914.	18,006.02	41,586.39	59,592.41	678,654.44
Jan. 1, 1915.	16,966.36	....	16,966.36	678,654.44
July 1, 1915.	16,966.36	41,586.39	58,552.75	637,068.05
Jan. 1, 1916.	15,926.70	....	15,926.70	637,068.05
July 1, 1916.	15,926.70	41,586.39	57,513.09	595,481.66
Jan. 1, 1917.	14,887.04	....	14,887.04	595,481.66
July 1, 1917.	14,887.04	41,586.39	56,473.43	553,895.27
Jan. 1, 1918.	13,847.38	....	13,847.38	553,895.27
July 1, 1918.	13,847.38	41,586.39	55,433.77	512,308.88
Jan. 1, 1919.	12,807.72	....	12,807.72	512,308.88
July 1, 1919.	12,807.72	41,586.39	54,394.11	470,722.49
Jan. 1, 1920.	11,768.06	....	11,768.06	470,722.49
July 1, 1920.	11,768.06	41,586.39	53,354.45	429,136.10
Jan. 1, 1921.	10,728.40	....	10,728.40	429,136.10
July 1, 1921.	10,728.40	41,586.39	52,314.79	387,549.71
Jan. 1, 1922.	9,688.74	....	9,688.74	387,549.71
July 1, 1922.	9,688.74	41,586.39	51,275.13	345,963.32
Jan. 1, 1923.	8,649.08	....	8,649.08	345,963.32
July 1, 1923.	8,649.08	41,586.39	50,235.47	304,376.93
Jan. 1, 1924.	7,609.42	....	7,609.42	304,376.93
July 1, 1924.	7,609.42	41,586.39	49,195.81	262,790.54
Jan. 1, 1925.	6,569.76	....	6,569.76	262,790.54
July 1, 1925.	6,569.76	41,586.39	48,156.15	221,204.15
Jan. 1, 1926.	5,530.10	....	5,530.10	221,204.15
July 1, 1926.	5,530.10	41,586.39	47,116.49	179,617.76
Jan. 1, 1927.	4,490.44	....	4,490.44	179,617.76
July 1, 1927.	4,490.44	41,586.39	46,076.83	138,031.37
Jan. 1, 1928.	3,450.78	....	3,450.78	138,031.37
July 1, 1928.	3,450.78	41,586.39	45,037.17	96,444.98
Jan. 1, 1929.	2,411.12	....	2,411.12	96,444.98
July 1, 1929.	2,411.12	41,586.39	43,997.51	54,858.59
Jan. 1, 1930.	1,371.46	....	1,371.46	54,858.59
July 1, 1930.	1,371.46	54,858.59	56,230.05	....
Total.....	$428,273.31	$823,764.40	$1,252,037.71	....

FINANCIAL STATEMENT, DECEMBER 31, 1913

ASSETS

ACCOUNTS RECEIVABLE		
Sundry Debtors. Metered Water	$ 11,762.98	
Sundry Debtors. Sundry Sales	46,460.11	
City of Seattle	376,653.05	
Suspense Accounts	2,764.37	
		$437,640.51
FUNDS		
Stamp Fund	750.00	
C. R. W. S. No. 2 Construction Fund	11,012.47	
C. R. W. S. 1910 Extension Fund	17,106.47	
C. R. W. S. 1913 Extension Fund	78,272.57	
		107,141.51
INVENTORIES		
Tools	8,454.96	
Automobiles	10,489.00	
Material	128,341.27	
Material, Fremont	15,886.59	
Horse, Harness and Wagon	5,057.20	
Store Expense	736.37	
Stables	200.18	
Pipe Lines	1,556.43	
Headworks	707.55	
Pump Stations	916.56	
Office	7,923.24	
Blacksmith	2,962.28	
		183,231.63
CONSTRUCTION		
Cost of Plant	11,707,323.38	
Depreciation	1,646,880.19	
Net Value		10,060,443.19
REAL ESTATE		
Appraised Dec. 31, 1912	1,226,154.42	
Additions 1913 out of Revenue	1,007.98	
Additions 1913 Condemnation Fund	9,425.82	
		1,236,588.22
GENERAL FUND		
Fireboat Snoqualmie	70,000.00	
24 years' Interest @ 5%	84,000.00	
		154,000.00
		$12,179,045.06

FINANCIAL STATEMENT—(Continued)

LIABILITIES

Fund Account	$ 82,314.89	
Sundry Debtors Fixed Rate	4,522.06	
Accounts Payable	6,374.86	
General Fund	4,881.47	
Condemnation Fund (Reserve)	9,425.82	
		107,519.10
WARRANTS AND BONDS PAYABLE		
C. R. W. S. No. 1 Warrants	510,000.00	
C. R. W. S. No. 2 Bonds	1,767,000.00	
Refunding Bonds 1910	720,240.81	
Refunding Bonds 1912	195,000.00	
C. R. W. S. Extension Bonds 1910	500,000.00	
C. R. W. S. Extension Bonds 1911	580,000.00	
Cedar River Condemnation Bonds 1912	500,000.00	
Ballard W. W. & E. L. Bonds 1895	42,000.00	
Ballard Water Bonds 1902	10,000.00	
Ballard Water Bonds 1904	25,000.00	
		4,849,240.81
Reserve for Interest Fire Boat Snoqualmie		84,000.00
CAPITAL INVESTMENT		
Investment by private property	3,767,171.77	
Investment by City	3,157,410.66	
Surplus 1913 absorbed in construction	213,702.72	7,138,285.15
		$12,179,045.06

PLANT ACCOUNT

C. R. W. S. No. 1.		
Pacific Bridge Co. (Pipe Line No. 1)	$ 793,630.00	
Smyth, Wakefield & David (Reservoir)	323,000.00	
Pay Roll Charges (Ord. 4045 and 4223)	4,993.37	
Sub. No. 1, 2, 3, 4 Watershed	23,240.92	
Bridges over Cedar River	9,582.23	
Headworks	14,996.59	
Pipe Line Additional Construction	10,122.52	
Unsegregated Charges	58,872.38	
C. R. W. S. No. 2		$1,238,438.01
Pipe Lines	1,538,325.29	
Subdivisions 1 to 6	268,358.99	
Beacon Hill Reservoirs	527,443.88	
Green Lake Intermediate Service Res.	186,590.51	
Green Lake Low Service Res.	182,157.81	
Green Lake Overflow	13,453.73	
Hubbell Way Main	68,437.50	
Lake Union Trestle	4,048.39	
Volunteer Park Overflow	15,401.35	
Settling Basin (Headworks)	4,415.00	
Lake Union 36 in. Pipe	7,854.02	
Harvard Ave. Mains	43,677.49	
Green Lake Supply Mains	24,472.72	
Magnolia Bluff Tower	14,995.77	
Interbay Pumping Station	14,946.40	
Pipe Line Betterment	15,016.52	
Mains		2,929,595.37
21st Ave. South and Spokane St.	15,048.22	
North 41st St.	75,332.29	
Mains and Hydrants, miscellaneous	32,203.52	
L. I. D. Mains, Distribution (Wood)	637,904.78	
L. I. D. Mains, Distribution (Iron)	4,411,092.31	
L. I. D. Paid by Department	628,018.55	
Special Ordinance	12,011.98	
Chelan Ave., Iron Main	11,689.71	
Twelfth Ave. South Tunnel	30,015.89	
Third Ave. N. W. Syphon Tunnel	26,884.45	
Pumping Stations	75,114.68	
Standpipes	102,262.82	
Taps connected	434,050.93	
Meters in use	412,161.19	
Installation Meters	125,018.06	
Headworks	1,318.23	
Latona Tunnel	1,727.43	
Old Systems Acquired		
Ballard Water System	89,394.80	
Fairmount Water System	1,764.27	
Columbia Water System	10,000.00	
Georgetown Water System (Part)	7,532.70	
Home Seekers Water System	2,500.00	
Rainier Valley Water System	32,111.08	
Spring Hill Plant	352,265.67	
Lake Union Plant	11,866.44	
	$7,539,290.00	7,539,290.00
		$11,707,323.38
Appraised value of real estate Dec. 31, 1913		1,236,588.22
Depreciation up to Dec. 31, 1912	1,451,764.85	12,943,911.60
Depreciation for 1913	195,115.34	
Total Depreciation		1,646,880.19
Physical value of plant on Dec. 31, 1913		$11,297,031.41

INTEREST AND REDEMPTION STATEMENT, JANUARY 1, 1914

Name of Issue	Rate	Date of Issue	Amount	Redeemed to Jan. 1, 1914	Unpaid Balance	Date of Interest Payment	Amount 1914	Date of Redemption	Amount 1914	Balance Jan. 1, 1915	Remarks
Refunding Bonds, 1910	5%	July 1, 1910	$ 845,000.00	$ 124,759.19	$ 720,240.81	July 1 Jan. 1	$ 18,006.02 16,966.36	July 1.	$ 41,586.40	$ 678,654.41	This issue refunds issue of 1890 Purchase and Extension of Water System.
Refunding Bonds, 1912	5%	July 1, 1912	205,000.00	10,000.00	195,000.00	July 1 Jan. 1	4,875.00 4,625.00	July 1	10,000.00	185,000.00	This issue refunds issue of 1892 Extension of Water System.
C. R. W. S. No. 1 Warrants	5%	1901	1,250,000.00	740,000.00	510,000.00	July 1 Jan. 1	12,750.00 11,825.00	July 1 Jan. 1	37,000.00 38,000.00	435,000.00	Construction of C. R. W. S. No. 1.
C. R. W. S. No. 2 Bonds	5%	1908	2,250,000.00	483,000.00	1,767,000.00	July 1 Jan. 1	44,175.00 44,175.00	Jan. 1	112,000.00	1,655,000.00	Construction of C. R. W. S. No. 2.
Water Extension Bonds, 1910	4½%	July 1, 1910	500,000.00		500,000.00	July 1	22,500.00			500,000.00	Extension of Water System.
Water Extension Bonds 1911	4½%	July 1, 1911	580,000.00		580,000.00	July 1 Jan. 1	13,050.00 13,050.00			580,000.00	Extension of Water System.
Cedar River Cond. Bonds, 1912	4½%	Jan. 1, 1912	500,000.00		500,000.00	July 1 Jan. 1	11,250.00 11,250.00			500,000.00	Purchase of Watershed.
Ballard W. W. and Elec. Lt. Bonds, 1895	6%	Jan. 1, 1895	42,000.00		42,000.00	July 1 Jan. 1	1,260.00 1,260.00	Dec. 31, 1914	42,000.00		Construction of Water Plant, Ballard.
Ballard W. W. Bonds, 1902	4½%	Aug. 1, 1902	10,000.00		10,000.00	Feb. 1 Aug. 1	225.00 225.00			10,000.00	Extension of Ballard Water Plant.
Ballard W. W. Bonds, 1904	4½%	Oct. 1, 1904	25,000.00		25,000.00	April 1 Oct. 1	562.50 562.50			25,000.00	Extension of Ballard Water Plant.
Columbia W. W. Bonds, 1902	6%	Jan. 1, 1908	4,980.00	4,980.00							Construction of Columbia Water System.
			$6,211,980.00	$1,362,739.19	$4,849,240.81		$232,592.38		$280,586.40	$4,568,654.41	
Bonds authorized, but not yet issued:											
C. R. Watershed Cond. Bonds			500,000.00								
For tunnel under Lake Wash. Canal			300,000.00								

Property of Water Department

Denny Hoyt Add.: Lots 7 and 8, Blk. 16. (Deed No. 39, Oct. 21, 1902.) Fremont Water Station General Fund	$ 350.00
Dunn's Add.: Lots 5, 6, 7, 8, 9, 10, 11, 12, Blk. A. (Deeds No. 56, 57, 58, 59, 60, 61, Dec. 1900.) Queen Anne Reservoir. By Water Fund.	$4,900.00 (Trans. to Park Dept., Ord. 27027.)
East Park Add.: S. 31′ of N. 120′ less W. 25′, Lot 35, Blk. 9 (Deed No. 552, July 9, 1907) By Water Fund.	$ 1.00
Lot 8, Blk. 11 Lots 3 and 10, Blk. 14 Reservoir Overflow.	Acquired by condemnation, Ord. 3990, Cause 31510.
Edgewater Add.: Lot 22, Blk. 5.	Acquired by condemnation, Ord. 23190, Cause 73356.
Furth's Add.: Lots 1 and 2, Blk. A. (Deed No. 710, July 10, 1908.) Reservoir.) Lot 1 used to widen Prospect St.) By Water Fund.	$ 5,500.00
Grand Boul. Add.: Lots 1 to 18, inc., Blk. 3. (Deed No. 1530, Dec. 10, 1909.) (Deed No. 993, Dec. 8, 1909.) By Water Fund.	$ 8,140.00
Gilman Park Add.: Lots 12, 13, 14, E. 15′ of S. 30′ Lot 9, S. 30′ Lots 10 and 11, Blk. 173 (Deed Vo.) 230 P. 515, March 29, 1895. Bought by City of Ballard.) (Ballard Elec. Co. holds lease for term of 50 years on all except Lot 14.)	$ 5,000.00
Latona Add.: Lot 9, Blk. 21 (Deed No. 5938, Aug. 16, 1911.) (By Water Fund.)	$1,125.00
Hillman's Meadow Garden Div. No. 4.: S. 50′ and E. 4′ of Reserve No. 3 in Blk. 33. Rainier Beach Water System.	(See tract 5 and 6, Sommerville Add.)

Maple Leaf Add. to Green Lake Circle:

Acres 1, 2 and 3, Blk. 3 Lots 1 to 6, Acre 5, Blk. 3 Acre 1, Blk. 4 S. ½ of Acres 3, 4 and 5, Blk. 14 (Deeds 542, 465, 463, 462 Dec. 1906. Water Fund.)	$5,300.00	(Trans. to Park Dept. Ord. 27236)

Lots 1 to 6,	Acre 4,	Blk. 3	Acquired by condemnation. Ord. 14142. Cause 52927 (Trans. to Park Dept. Ord. 27236)
" 1 to 6,	" 2,	" 4	
" 1 to 6,	" 3,	" 4	
" 4, 5 and 6	" 1,	" 13	
" 1, 4, 5 and 6,	" 2,	" 13	
" 5 and 6,	" 3,	" 13	
" 4, 5 and 6,	" 1,	" 14	
" 4, 5 and 6,	" 2,	" 14	

Mercer's 2d Add.:
Lots 3 and 4, Blk. 33 — $5,000.00
(Deed No. 62, Aug. 12, 1891)
Queen Anne Pumping Sta.
General Fund, Bo't with Union Water Co. System.

Jno. H. Nagle's 2d Add.:
Blks. 29, 36 and E. ½ of Blks. 30 and 35 — $10,800.00
(Deed No. 66, July 26, 1897.)
Lincoln Park Res.
Water Fund, $7,620.90
Park Fund, $3,179.10

Perkins' Green Lake Add.:
Blks. 6, 7 and 8 — $14,000.00
(Deed No. 437, July 3, 1906)
Water Fund.

Pitner's 3d Div. to Green Lake Add.:

Lots 1, 2, 3 and 4, Blk. 1 " 32, 33, 37, 38, 39, 40, Blk. 1 (Deeds 442, 446, Oct. 8, 1906)	$2,500.00	Trans. to Park Dept. Ord. 27236 Water Fund.
Lots 1 to 10 and 31 to 35, Blk. 2 (Deeds 441 and 458, April 7, 1906)	$6,400.00	
Lots 1 to 10 and 31 to 40, Blk. 3 (Deeds 437, 444, 445, 459, 460 and 461, July 10, 1906)	$5,770.00	
Lots 5 to 10, 31, 34, 35 and 36, Blk. 1 " 36 to 40, inc., Blk. 2	Acquired by Cond. Ord. 13942 Cause 52190	(Trans. to Park Dept. Ord. 27236)

Scenic Heights Add. to West Seattle:
Lot 1, Blk. 9 — $1,600.00
(Deed 883, April 12, 1909)
Water Fund

Steel Works Add.:
Lots 9, 10, 11 and 12, Blk. 3 — $2,200.00
(Deed No. 878, April 14, 1909)
Water Fund

Sommerville 5 Acre Tracts, Criegel's Sub. Div. of Tract G.:
Tracts 5 and 8, less E. 100 ft.; and sundry other parcels.
(Deed 714, March 10, 1908—Deed Price
$32,000.00 incl. const. of plant) — $1,000.00
Rainier Beach Water System
Water Fund

Terry's 2d Add.:
Part of Blk. 85—Com. where N. line H. L. Yesler's Don. Cl. intersects E'ly line sd. Blk.; th. W'ly on N. line sd. Cl. to E'ly line of alley in sd. Blk.; th. S'ly on E'ly line of alley to Fir St.; th. E'ly on Fir. St. to Bdway.; th. N'ly on Bdway. to beg. — $9,000.00
(Old Spring Hill Water System Deed V110 P458, Oct. 27, 1890)
(Trans. to Park Dept. Ord. 22940)

Thomas' Div. to Green Lake Add.:
Blk. 1, Lots 1 to 40 inc.
" 2, " 1 to 40, inc.
— Acquired by Cond. Ord. 14142 Cause 52927
(Trans. to Park Dept. Ord. 27236)

Vacher's Div. to Green Lake Add.:
Lots 1 to 12, inc., Blk. 1 — $1,467.00
(Deed 466, Dec. 6, 1906)
Water Fund
Lots 1 to 6, inc., Blk. 2 — 975.00
(Deed 440, July 26, 1906)
Water Fund
Lots 13 to 24, inc., Blk. 1
" 7 to 24, " " 2
" 1 to 12, " " 3
— Acquired by Cond. Ord. 13942 Cause 52190
— Trans. to Park Dept. Ord. 27236

Wood's Green Lake Park Add.:
Lots 14 to 23, inc., Blk. 11
" 4 to 32, " " 20
— Acquired by Cond. Ord. 13942 Cause 52190

T. 23 N., R. 4 E.:
In Sec. 3.
A strip 4′ wide and 660′ long across N. line of S. ½ of N. E. ¼ of S. E. ¼ of N. E. ¼. and lot in N. W. cor. sd. tract 50′ E. and W. and 100′ N. and S. conn. with sd. strip
Deed 714
Rainier Beach Water System
— See tract 5 and 6 Sommerville Add.

T. 24 N., R. 4 E.:
In Section 16.
E. ½ of S. W. ¼; S. E. ¼ of N. W ¼; N. W. ¼ of S. W. ¼; S. W. ¼ of N. W. ¼ and all Gov't lot 5, containing 235.186 Acres, less 101.389 Acres, Trans. to Park Dept. Ords. 20174 and 28380.
(Deed 291, Feb. 18, 1904)
(P. S. E. Ry. has 15′ R-W through above Sec.)
— $11,771.00 (Gen'l Fund)

In Section 21.
Beginning at a point 16 rods W. of S. E. cor. of S. W. ¼; th. W. 4 rods; th. N. 40 rds.; th. E. 4 rds.; th. S. 40 rds. to beg., less 30′ off S. line for County Road.
(Deed 503, April 29, 1910)
Water Fund
— $7,000.00 (Bot. of Georgetown Water Co.)

T. 24 N., R. 4 E—(Continued):

In Section 21.

Com. at N. W. cor. of S. E. ¼ of N. E. ¼; th. S. 80′ th. E. 80′; th. N. 80′; th. W. 80′ to beg.	$1,000.00

(Deed 1802, Aug. 18, 1902)
Columbia Reservoir,
Town of Columbia Annexation.

In Section 22.

A Str. 4′ wide off S. side of S. W. ¼ of S. W. ¼ of S. W. ¼ and off W. ½ of S. E. ¼ of S. W. ¼ of S. W. ¼, also A 16″ str. along the S. line of E. ½ of S. E. ¼ of S. W. ¼ of S. W. ¼	See Tracts 5 and 6 Sommerville Add.

(Deed 714)
Rainier Beach Water System.

T. 25 N., R. 3 E.:

In Section 2.

Com. 10 rds. W. and 16 rds. S. of N. E. cor. of N. ½ of N. E. ¼ of S. W. ¼; th. E. 10 rds.; th. S. 16 rds.th. W. 10 rds.; th. N. 16 rds. to bg.Cont. 1 Acre .	$1,500.00

(Deed 657, Sept. 11, 1903)
City of Ballard Annexation.

T. 25 N., R. 4 E., W. M.:

In Section 5.

Pt. of N. E. ¼ of N. E. ¼ of N. E. ¼	Acquired by Cond. Ord. 14142 Cause 52927

T. 22 N., R. 4 E., W. M.:

In Section 10.

Tract described as follows: Com. at a point 502′ E. of N. W. cor. of lot 2; th. E'ly 619′ to shore of Lk. Wash.; th. S'ly 24° W. 330′; th. W'ly 483′; th. N'ly 303½′ to place of beg., contng. 5 Acres, more or less. Appraised at $20,000.00
Ord. 1279 Pur. with Spring Hill Water Sys.
Trans. to Park Dept. Ord. 16570
Lake Wash. Pumping Sta.

Burke's 2d Add.:

Lots 1, 2, 3 and 4,	Blk. 37
" 1 to 8	" 38
" 1 to 8	" 63
" 1 to 8	" 64
" 1 to 10	" 84

Appraised at $20,000.00
Ord. 1279 Pur. with Spring Hill Water Sys.
Trans. to Park Dept. Ord. 16570
Lake Wash. Pumping Sta. and R-W for Force Main.

Central Seattle Add.:

All of Blk. 15
Appraised at $12,000.00
Ord. 1279 Pur. with Spring Hill Water Sys.
Trans. to Park Dept. Ord. 16570
Beacon Hill Res.

Central Seattle Addition:
Lots 2, 4, 5, 6, 7, 9 and 10, Blk. 6
" 3, 5, 6, 7, 8, 9 and 10, " 7
" 8, 9 and 10, " 8
" 1, 2, 3, 4, 5, 7, 9 and 10 " 9
" 11, " 5

McNaught's 3d Addition:
Lots 7, Blk. 1
" 1, 2, 7 and 8, " 3
" 1, 2, " 4

J. C. Kinnear's Addition:
Lots 1, 2, 3, 4, 5 and 6, Blk. 3

Appraised at $20,000.00
Ord. 1279
Pur. with Spring Hill Water Sys.
Trans. to Park Dept.
Ord. 16570

Fauntleroy Crest Addition:
Lots 11, 12, 13 and 14, Blk. 6 $2,186.73

LAND ACQUIRED BY CONDEMNATION

ORD. OF CONDEM. 3990

Causes 25333 and 24650—Date of judgment October 1, 1898, September 27, 1898. Consideration, $26,244.04. Paid by Ordinance 5129. Water Fund.

Description

Township 24 North, Range 4 East, Willamette Meridian
Part of Secs. 8, 21, 27, 28 and 34.

Township 23 North, Range 4 East, Willamette Meridian
Part of Secs. 2, 3, 11, 13 and 14.

Township 23 North, Range 5 East, Willamette Meridian
Part of Secs. 17, 18 and 20.

Township 22 North, Range 5 East, Willamette Meridian
Part of Secs. 1, 2, 11 and 12.

Township 25 North, Range 4 East, Willamette Meridian
Part of Sec. 29.

Township 22 North, Range 7 East, Willamette Meridian
All of Sec. 19 (covered also by Deed No. 67).

ORD. OF CONDEM. 3990

Cause 31510—Date of judgment, August 1, 1901. Consideration, $13,500.00. Paid by Ordinance 7164. Water Fund.

Description

Township 23 North, Range 5 East, Willamette Meridian
Part of Secs. 21, 27, 28. 35.

Township 22 North, Range 6 East, Willamette Meridian
Part of Secs. 5, 6, 8, 9, 15, 22, 23 and 24.

Township 22 North, Range 7 East, Willamette Meridian.
Part of Secs. 8, 9, 14, 16, 18 and 22.

Township 22 North, Range 9 East, Willamette Meridian
Part of Secs. 18, 20, 22 and 26.

East Park Addition, Lot 8, Block 11; Lots 3 and 10, Block 14.

ORD. OF CONDEM. 3990

Cause 28363—Date of judgment June 30, 1900, November 14, 1900. Consideration, $1,071.40. Paid from Water Fund.

Description

Township 23 North, Range 5 East, Willamette Meridian
Part of Sec. 26.

Township 22 North, Range 6 East, Willamette Meridian
Part of Sec. 24.

Township 25 North, Range 4 East, Willamette Meridian
Part of Sec. 32.

ORD. OF CONDEM. 5803

Cause 34001—Date of judgment March 3, 1902. Consideration, $53,002.00. Paid by Ordinance 7847. Water Fund.

Description

Township 22 North, Range 8 East, Willamette Meridian
Part of Sec. 3 and 11.

ORD. OF CONDEM. 10723

Cause 42455—Date of judgment October 18, 1904. Consideration, $14,651.40. Paid by Ordinance 11369. M. L. & P. Fund. (Re-imbursed from Water Fund on Ordinance 13186, January 9, 1906.

Description

Township 22 North, Range 7 East, Willamette Meridian
Part of Secs. 2, 4, 5, 8, 9, 10, 14, 15, 16, 17, 18, 20 and 22.

Township 22 North, Range 8 East, Willamette Meridian
Part of Secs. 1, 6, 12, 13, 16, 18, 20, 23, 25, 29 and 30.

Township 22 North, Range 9 East, Willamette Meridian
Part of Secs. 16, 17, 19, 20, 21, 22, 23, 27, 29, 30, 31, 33 and 36.

Township 23 North, Range 7 East, Willamette Meridian
Part of Sec. 34.

Township 23 North, Range 8 East, Willamette Meridian
Part of Sec. 32.

Township 22 North, Range 10 East, Willamette Meridian
Part of Secs. 19, 27, 29, 31, 33 and 36.

ORD. OF CONDEM. 14142

Cause 52927—Date of judgment January 18, 1907. Consideration, $23,054.00. Paid by Ordinance 15237. From Water Fund. (Transferred to Park Department by Ordinance 27236, January 15, 1907.)

Description

Maple Leaf Addition
Block 3, Lots 1, 2, 3, 4, 5 and 6. Acre 4
Block 4, Lots 1, 2, 3, 4, 5 and 6. Acre 2
Block 4, Lots 1, 2, 3, 4, 5 and 6. Acre 3
Block 13, Lots 4, 5 and 6. Acre 1; 4, 5 and 6. Acre 2; 5 and 6. Acre 3
Block 14, Lots 4, 5 and 6. Acre 1; 4, 5 and 6. Acre 2

Thomas' Division to Green Lake Addition
Block 1, Lots 1 to 40, inclusive
Block 2, Lots 1 to 40, inclusive

Township 25 North, Range 4 East, Willamette Meridian
In Sec. 5; Part of the NE¼ of NE¼ of NE¼

ORD. OF CONDEM. 13942

Cause 52190—Date of judgment February 7, 1907. Consideration, $20,200.00. Paid by Ordinance 15367. Water Fund. (Transferred to Park Department by Ordinance 27236, January 15, 1907.)

Description

Pitner's 3d Division to Green Lake Addition
Block 1, Lots 5 to 10, inclusive, 31, 34, 35 and 36
Block 2, Lots 36 to 40, inclusive

Vacher's Division to Green Lake Addition
Block 1, Lots 13 to 24, inclusive
Block 2, Lots 7 to 24, inclusive
Block 3, Lots 1 to 12 inclusive

Wood's Green Lake Park Addition
Block 11, Lots 14 to 23, inclusive
Block 20, Lots 4 to 32, inclusive

ORD. 23190

Cause 73356—Date of judgment August 10, 1910. Consideration, $1,525.50. Paid by Ordinance 24798. Water Fund.

Description

Lot 22, Block 5, Edgewater Addition
Township 22 North, Range 6 East, Willamette Meridian

	No. of Acres
In Section 5	
66′ R-W in S½ of SE¼	3.16
Triangle NE corner of SE¼ of SW¼	05
Except coal and timber N. P. Ry. Co.	
100′ R-W S½ of SE¼	4.47
Pt. NW¼ of SE¼	.04
Pt. SE¼ of SW¼	.08
Weyerhauser Tbr. Co. reserves mineral rights.	
100′ R-W NE¼ of SW¼	1.03
100′ R-W NW¼ of SW¼	1.04
66′ R-W NE¼ of SW¼	2.34
66′ R-W NW¼ of SW¼	1.98
In Section 6	
66′ R-W NE¼ of SE¼	2.08
66′ R-W NW¼ of SE¼	2.08
66′ R-W NE¼ of SW¼	2.06
66′ R-W Lot 6	2.09
In Section 8	
66′ R-W NE¼ of NE¼	2.00
66′ Strip SW side of R-W NE¼ of NE¼	2.55
In Section 9	
40′ R-W SW¼ of SE¼ and E½ of SW¼	2.75
Str. of land less R-W	9.45
Except coal, timber and minerals, Weyerhauser Tbr. Co.	
66′ R-W through Sec., except strip heretofore conveyed	8.71
Except coal, N. P. Ry. Co.	

In Section 15	
66′ R-W SE¼ of SW¼ and W½ of SW¼	5.01
Except coal, N. P. Ry. Co.	
Tract SW of R-W in SW¼	7.36
40′ R-W W½ of SW¼	1.81
In Section 22	
66′ R-W S½ of N½ of NE¼ of SE¼	.35
66′ R-W N½ of N½ of NE¼ of SE¼	1.00
Tract in S½ of N½ of NE¼ of SE¼	.37
Tract in N½ of N½ of NE¼ of SE¼	.50
Strip in Lot 3, SW¼ of NE¼	2.47
Tract southerly side	.58
66′ R-W NW¼ of NE¼ and NE¼ of NE¼	2.56
In Section 23	
All Lot 10	14.00
N 198′ of SE¼ of NE¼	6.00
Except 40′ R-W previously deeded	
100′ R-W, Lot 9	4.50
Tract in Lot 9	11.39
NW corner pt. NW¼ of SE¼	1.24
SE corner pt. Lot 8	.22
Except R-W C. M. & St. P. Ry. in Lots 8, 9, 10, 11 and NW¼ of SW¼	
100′ R-W Lot 11	3.60
100′ R-W NW¼ of SW¼	3.68
Tract S½ of NW¼ of SW¼ and S½ of NW¼ of NW¼ of SW¼	21.32
Except 100′ R-W previously acquired	
SW¼ of SW¼	.40
40′ R-W SE¼ of NE¼	1.26
40′ R-W SE¼ of SW¼ and Lot 11	1.41
In Section 24	
66′ R-W, Lot 12	2.06
Strip S side R-W, Lot 12	1.15
66′ R-W, Lot 12	2.06
135′ R-W, Lots 8, 11 and 75′ R-W, Lots 7 and 8	7.22
NE corner pt. of NE¼ of SW¼	.30
66′ R-W, Lots 2 and 5	2.27
Lots 2 and 5	38.50
100′ R-W, Lot 6	.625
Tract, Lot 6	2.50
Township 22 North, Range 5 East, Willamette Meridian	
In Section 1	
66′ R-W NE¼ of SE¼ and Lot 7	4.28
66′ Spur R-W to Swan Lake, Lot 7	.76
Pt. Lot 7, Acct. overflow Swan Lake	9.66
66′ R-W through Lots 5 and 6	4.19
Pt. Lots 5 and 6, account overflow Swan Lake	4.91
Pt. SE¼ of SE¼ and Lot 8, account overflow Swan Lake	16.65
66′ R-W, Lot 4	1.46
Pt. Lot 4, account overflow Swan Lake	1.00
All of Lot 9	12.50
S½ of NE¼ of SE¼	20.00
S½ of NE¼ of NE¼ of SE¼	5.00
S½ of NE¼ of SE¼ being part of Lot 7	14.00
S½ of NE¼ of NW¼ of SE¼ being part of Lot 7	5.00

In Section 2	
All of Lot 1	9.75
In Section 11	
Pt. of Lot 1, account overflow Swan Lake	2.15
E pt. of Lot 2, except coal, (N. P. Ry. Co.)	22.05
Pt. Lot 3, account overflow Swan Lake	2.93
E pt. Lot 4	9.66
All Lot 5	35.00
In Section 12	
W pt. of Lot 1	17.73
All of Lot 2	33.75
Township 23 North, Range 5 East, Willamette Meridian	
In Section 17	
R-W E. pt. of SW¼	3.20
Town of Renton	
Pt. Lots 12, 13, 14, 15, 16, 17, Block 4	.32
Pt. Lot 6, Block 4	.002
Pt. Lot 5, Block 4	.04
Pt. Lot 4, Block 4	.11
Pt. Lot 3, Block 4	.062
Pt. Lot 17, Block 9	.04
Pt. Lot 18, Block 9	.12
Pt. Lot 19, Block 9	.027
Pt. Lot 1, Block 9	.067
W Pt. of Lot 16, Block 4	.061
In Section 17	
Renton Co-operative Coal Co.'s Acre Tracts, Strip in Tracts 4, 6 and 7	
15′ off W end Lot 43, Plat 1	.506
Township 23 North, Range 5 East, Willamette Meridian	
Section 18	
66′ R-W NE¼ of SE¼, Tobin's Don. claim	.13
66′ R-W 5 Acre Tract in NE¼ of SW¼	.51
66′ R-W Tobin's Don. claim to center of Black River, E½	2.33
66′ R-W center of Black River to W line in N½	4.53
In Section 20	
66′ R-W NE¼ of SE¼	.63
66′ R-W E½ of NE¼	2.23
66′ R-W pt. of W¾ of N½	3.09
In Section 21	
100′ R-W SE¼ of SE¼	1.65
40′ R-W SW¼ of SE¼	1.25
2 strips 20′ and 40′ both sides	
R-W SW¼ of SE¼	1.855
40′ R-W SW¼	2.97
2 R-W 20′ and 40′; both sides of R-W in SW¼	4.45
In Section 26	
66′ R-W SW¼	4.71
In Section 27	
40′ of R-W N½	5.34
66′ R-W N½ less 5.34 acres (40′ R-W)	3.57

In Section 28	
100′ R-W NE¼ of NE¼	3.04
66′ R-W E½ of NW¼	9.00
In Section 35	
66′ R-W S½ of SE¼	2.03
66′ R-W to Swan Lake, S½ of SE¼	2.00
Pt. S½ of SE¼, account overflow Swan Lake	12.42
Tract through N½ of SE¼	5.73
66′ R-W SE¼ of NE¼	2.35
40′ R-W W½ of NE¼ and NE¼ of NW¼	1.98
2 strips E side R-W W½ of NE¼ and NE¼ of NW¼	1.30
Tract in N½ of SE¼	10.33
Township 23 North, Range 4 East, Willamette Meridian	
In Section 2	
66′ R-W SW¼ of SW¼	1.03
In Section 3	
E½, Lots 14 to 20, inc., Blk. 10, Pottery Works Add.	.28
Lots 14 to 26, inc., Blk. 1, Pottery Works Add.	1.02
66′ R-W, S½ of NE¼ of SE¼	.98
66′ R-W, NE¼ of NE¼ of SE¼	1.03
66′ R-W, SE¼ of SE¼ of NE¼	1.09
66′ R-W, S½ of NE¼ of SE¼ of NE¼	.30
66′ R-W, NW¼ of SE¼ of NE¼	.78
66′ R-W, Lots 13, 14, 15, Bradner's Garden Tracts	.50
66′ R-W, Lots 7, 8, 9, Bradner's Garden Tracts	.50
66′ R-W, NW¼ of NE¼ of NE¼	1.03
In Section 11	
66′ R-W, SE¼ of SE¼	2.33
66′ R-W, SW¼ of SW¼	.41
66′ R-W, NW¼ of SE¼	2.50
66′ R-W, S½ of SW¼ of NE¼	.31
66′ R-W, SE¼ of NW¼	2.59
SW cor. pt. of NE¼ of NW¼	.005
NE cor. pt. of SW¼ of NW¼	.06
66′ R-W, NW¼ of NW¼	2.74
In Section 13	
66′ R-W, NE¼	4.10
66′ R-W, Lot 8	1.83
NE cor. pt. of C. Brownell's Don. claim	1.25
NE cor. pt. Lot 9	.004
SW cor. pt. Tract 7, Aldergrove Add. in NE¼ of NW¼	.04
66′ R-W, NW¼ of NW¼	2.17
In Section 14	
66′ R-W, NE¼ of NE¼	1.52
Township 24 North, Range 4 East, Willamette Meridian	
In Section 8	
Pt. of Lots 5, 6, 7, Blk. 50, Hanford's Add. to So. Seattle	1.17
Pt. of Lot 6, Bayside Add. to City of Seattle	.547
Pt. of Lot 7, Bayside Add. to City of Seattle	.17
Pt. of Lot 18, Blk. 5, Carney's Suppl. Tr. 5, Bayside Add. to City of Seattle	.014
Pt. Lots 19 and 20, Blk. 5, Carney's Suppl. Tr. 5, Bayside Add. to City of Seattle	.136
Pt. Lots 7, 8, 9, Blk. 6, Walker's Add. to City of Seattle	.112
Pt. Lots 1 to 6, inc., Blk. 6, Walker's Add. to Seattle	.403
Pt. Lot 11, McNaught's Suppl. Plat to Central Seattle	.025
Pt. Lot 1, Blk. 73, McNaught's Suppl. Pl. to Central Seattle	.009
Pt. Lot 2, Blk. 7, McNaught's Suppl. Plat to Central Seattle	.001

In Sections 9 and 16	
Pt. of E. Hanford's Don Cl. No. 441	.27
In Section 9	
Riley's Addition to Riley's Addition to South Seattle	
Pt. of Lot 1, Block 57	.121
Pt. of Lot 2, Block 57	.088
Pt. of Lot 3, Block 57	.055
Pt. of Lot 4, Block 57	.021
Pt. of Lot 5, Block 57	.0003
T. Hanford's Addition to South Seattle	
Pt. of Lots 5, 6, 7 and 8, Block 52	.372
Pt. of Lots 3 and 4, Block 52	.073
Pt. of Lot 1, Block 51	.112
Pt. of Lot 2, Block 51	.06
Pt. of Lot 3, Block 51	.011
In Section 21	
Sommerville 5-Acre Tracts	
66′ R-W, Tract G	.49
66′ R-W, Tract F	.49
66′ R-W, Tract C	.49
66′ R-W, Tract D	.49
66′ R-W, Tract 13	.49
66′ R-W, Tract 12	.45
Pt. of Tract 5	.04
66′ R-W, NW¼ of SW¼	.89
66′ R-W, E½ of NW¼	4.18
In Section 27	
Riverside Addition to City of Seattle	
Pt. Lots 1, 2, 3 and 4, Block 19	.15
Pt. Lots 1, 2, 3, 4 and 5, Block 20	.15
Pt. Lots 3 to 8 inc., Block 23	.16
Pt. Lots 5 to 9 inc., Block 24	.16
Pt. of Lots 7 to 11 inc., Block 27	.16
Pt. Lots 8 to 12 inc., Block 28	.16
Pt. Lots 10, 11 and 12, Block 31	.08
Pt. Lots 12, Block 32	.007
Pt. Lots 1, 2 and 3, Block 30	.09
Pt. Lots 1, 2, 3, 4 and 5, Block 33	.16
66′ R-W, Govt. Lot 1	.54
66′ R-W, NW¼ of SW¼	.33
In Section 28	
Sommerville 5-Acre Tracts	
66′ R-W, E½ Tract 48	.33
66′ R-W, Tract 39, 42 to 45	2.28
66′ R-W, Govt. Lot 10	1.77
66′ R-W, S. Maple's don. cl.	1.27
66′ R-W, Tract K	.63
66′ R-W, Tract J	.50
In Section 34	
Plat of Rainier Beach	
Pt. of Lot 10, Block 87	.01
Pt. of Lot 18, Block 73	.009
Pt. of Lots 1 to 9 inc., and 14 to 18 inc., Block 86	.60
Pt. of Lots 7, 8 and 9, Block 74	.24
Pt. of Lots 12, 13, 14 and 15, Block 84	.19
Pt. of Lots 1 to 5 inc., Block 92	.23
Pt. of Lots 12, 13 and 14, Block 92	.15
Pt. of Lots 8 and 9, Block 83	.08

Pt. of Lots 4, 5, 6, 23, 24 and 25, Block 82	.33
Pt. of Lots 1 to 5 inc., and 25, 26, 27, 28, Block 81, Pl. Rainier Beach	.33
66′ R-W, NE¼ of SW¼	2.63
66′ R-W, Pt. Govt. Lot 2	.45
66′ R-W, Pt. Govt. Lot 3	.30
66′ R-W, Van Asselt Don. Cl.	.57
66′ R-W, Van Asselt Don. Cl.	2.78

Riverside Addition City of Seattle

Pt. Lots 7 and 8, Block 11	.09
Pt. Lots 7 and 8, Block 10	.07
Pt. Lots 7 and 8, Block 9	.006
Pt. Lot 1, Block 16	.05
Pt. Lots 1, 2, Block 15	.004

TOWNSHIP 25 NORTH, RANGE 4 EAST, WILLAMETTE MERIDIAN

In Section 29

66′ R-W, SE¼ of NE¼ (12th Ave. N. Ext.)	1.819
N. 15′ Lot 3, Blk. 14, E. T. Denny's E. Pk. Add. in NW¼	
N. 15′ Lot 13 Blk. 14, E. T. Denny's E. Pk. Add. in NW¼	
S. 45′ Lot 8, Blk. 11, E. T. Denny's E. Pk. Add. in NW¼	

In Section 32

Pt. Lot 2	.0507

LANDS IN THE CEDAR RIVER WATERSHED OWNED BY THE CITY OF SEATTLE

TOWNSHIP 22 NORTH, RANGE 7 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
1	518.31	Entire Sec. except R-W of G. R. & N. Ry. City owns land only. Timber and coal reserved by Northwestern Impr. Co.
2	266.52	E½ except R-W of G. R. & N. Ry. City owns lands, timber and minerals.
....	1.51	Lot in SW¼ of SW¼. City owns land, timber and minerals. N. 330′ of S. 360′ of W. 660′ of SW¼ of SW¼.
....	3.49	Lot in SW¼ of SW¼. City owns land, timber and minerals. N. 330′ of S. 360′ of W. 660′ of SW¼ of SW¼.
4	483.51	Entire Sec. except E½ of NE¼, and parts of R-W of C. & P. S. Ry. City owns land, timber and minerals.
5	391.82	N¾ of Sec. City owns land, timber and minerals.
8	160.00	E½ of E½. City owns land, timber and minerals.
9	500.45	E½, NE¼ of NW¼; Lots 1, 3, 4, 5 and 7. City owns lands, timber and minerals. In Lot 7 and in SW¼ of NE¼ of NW¼, J. E. Bell reserves exclusive use and occupation and right to raft logs on Walsh Lake till July 19, 1921.
....	9.05	Lot 2. City owns land. L. E. Gaffney reserves timber, buildings and right to mine.
....	19.40	Lot 6. City owns land. N. P. Ry. reserves timber and mineral rights.
10	320.00	S½. City owns land, timber and minerals.

Sec.	Area, Acres	Description
....	10.00	NE¼ of NE¼ of NE¼. City owns land. Louis Ek reserves clay and mineral rights. City also owns mineral rights in NW¼, but does not own the land.
11	635.88	Entire Sec. except R-W of G. R. & N. Ry. City owns land. Coal reserved by Northwestern Imp. Co.
12	616.23	Entire sec., except R-W of G. R. & N. Ry. City owns land and mineral. Kent Lumber Co. reserves timber till July 1, 1941.
13	591.41	Entire sec. except R-W of G. R. & N. Ry. and C. M. & St. P. Ry. City owns land and minerals. Kent Lumber Co. reserves timber on part of Sec. till July 1, 1941, and on part of Sec. till October 1, 1914. Reserves use of mill buildings till December 31, 1918, and right to remove same, also use of water rights till July 1, 1921.
14	475.06	N½; N½ of NW¼ of SW¼; NE¼ of SW¼; N½ of SE¼; N½ of SE¼ of SE¼, except R-W of G. R. & N. in NE¼. City owns land, timber and minerals.
....	153.03	S½ of NW¼ of SW¼; S½ of SW¼; SW¼ of SE¼; S½ of SE¼ of SE¼; except R-W of C. M. & St. P. Ry. City owns land only. State Agriculture College reserves timber and coal.
15	540.00	N½; SW¼; NW¼ of SE¼; N½ of NE¼ of SE¼. City owns land, timber and minerals.
....	20.00	S½ of NE¼ of SE¼. City owns land and minerals. Weyehauser Timber Co. reserves timber.
....	77.99	S½ of SE¼, except R-W of C. M. & St. P. R. R. City owns land and timber. N. P. Ry. reserves coal.
16	471.03	NE¼; W½ of NW¼; NE¼ of SE¼; S½ of SE¼; S½ of SW¼; NW¼ of SW¼, except R-W of C. M. & St. P. Ry. City owns land, timber and minerals.
....	160.00	E½ of NW¼; NE¼ of SW¼; NW¼ of SE¼. City owns land. Timber reserved by J. G. McLean, et al.
17	628.82	Entire Sec. except R-W of C. M. & St. P. Ry. City owns land and minerals. Weyerhaeuser Timber Co. reserves right to once log.
18	109.58	E½ of SE¼; E¼ of W½ of SE¼; SE¼ of SE¼ of NE¼, except R-W of C. M. & St. P. Ry. City owns land, timber and minerals.
....	91.31	W¾ of W½ of SE¼; N½ of SE¼ of NE¼; SW¼ of SE¼ of NE¼. City owns land. Timber reserved.
19	553.37	Entire sec. except R-W of C. M. & St. P. Ry. City owns land, timber and minerals.
20	34.83	That part of NW¼ of SW¼, lying N. of H. T. Pole Line. City owns land, timber and minerals.
21	40.00	NE¼ of NE¼. City owns land. N. P. Ry. Co. reserves coal and timber.
....	20.00	NE¼ of NW¼ of NE¼; NE¼ of SE¼ of NE¼. City owns land. N. W. Imp. Co. reserves coal and right to once log.
....	157.00	NE¼ of NW¼; W½ of NW¼ of NE¼; SE¼ of NW¼ of NE¼; SW¼ of NE¼; W½ of SE¼ of NE¼; SE¼ of SE¼ of NE¼; that part of N½ of SE¼ lying N of H. T. Pole Line. City owns land, timber and minerals.

Sec.	Area, Acres	Description
22	50.00	NE¼ of NW¼; NE¼ of NW¼ of NW¼. City owns land, timber and minerals.
....	182.87	W¼ of NE¼ of NE¼; W½ of NE¼; S½ of NW¼; W½ of NW¼ of NW¼; SE¼ of NW¼ of NW¼; except R-W of C. M. & St. P. Ry. City owns land. State Agricultural College reserves coal and timber.
....	230.00	N½ of S½; SE¼ of NE¼; E¾ of NE¼ of NE¼. City owns land. Kent Lbr. Co. has right to log till October 1, 1921.
23	79.59	S½ of NE¼, except R-W of G. R. & N. Ry. City owns land, timber and minerals.
....	83.56	N½ of NE¼; NE¼ of NE¼ of NW¼; except R-W of C. M. & St. P. Ry and G. R. & N. Ry. City owns land and timber, N of G. R. & N. Ry. R-W. City owns land only S of said R-W. N. W. Imp. Co. reserving timber. N. W. Imp. Co. reserves coal on entire description.
24	316.86	N½, except R-W of G. R. & N. Ry. and C. M. & St. P. Ry. City owns land and minerals. Kent Lbr. Co. reserves right to log till October 1, 1914.
	9,002.48	Total land owned by City in Township 22 N., Range 7 East, Willamette Meridian.

TOWNSHIP 23 NORTH, RANGE 7 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
26	49.53	Part of SW¼. City owns land. T. Kenny reserves timber rights until 1946 and coal and clay rights until 2011.
27	400.00	S½; S½ of NW¼. City owns land only. N. W. Imp. Co. reserves coal and timber.
34	160.00	NW¼. City owns land, timber and minerals.
35	440.00	W½; W½ of SE¼; SE¼ of SE¼. City owns land. N. W. Imp. Co. reserves coal and timber.
	1,049.53	Total land owned by City in Township 23 North, Range 7 East, Willamette Meridian.

TOWNSHIP 21 NORTH, RANGE 8 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
1	130.00	Lots 1, 2, 3 and 4. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
3	608.80	Entire sec. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
4	80.00	S½ of NE¼. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
....	64.20	Lots 1 and 2. City owns land only. Page Lbr. Co. owns timber.
5	....	City owns mineral rights only, no land, for entire sec., 611.40 acres.
9	....	City owns mineral rights only, no land for NW¼, 160 acres.
10	80.00	N½ of NE¼. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
....	30.00	N¾ of NE¼ of NW¼. City owns land only. Page Lbr. Co. owns timber.
	993.00	Total land owned by City in Township 21 North, Range 8 East, Willamette Meridian.

TOWNSHIP 22 NORTH, RANGE 8 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
1	160.00	S$\frac{1}{2}$ of S$\frac{1}{2}$. City owns land, timber and minerals.
2	80.00	S$\frac{1}{2}$ of SW$\frac{1}{4}$. City owns land. Weaver owns timber.
3	280.00	SW$\frac{1}{4}$; W$\frac{1}{2}$ of SE$\frac{1}{4}$; SE$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land, timber and minerals.
....	40.00	NE$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land, coal and minerals. N. P. Ry. Co. reserves timber.
....	106.70	NE$\frac{1}{4}$. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
4	55.01	Lot 4 and SW$\frac{1}{4}$ of NW$\frac{1}{4}$. City owns land and minerals. Weyehauser Timber Co. reserves timber till July 1, 1946.
....	40.00	SE$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land. Weyerhauser Tbr. Co. reserves timber till July 1, 1946 and mineral rights.
....	40.00	SW$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land and timber. Weyerhauser Tbr. Co. reserves mineral rights.
....	60.00	S$\frac{1}{2}$ of NW$\frac{1}{4}$ of SE$\frac{1}{4}$; NE$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land. Milwaukee Land Co. has timber rights till September 8, 1945.
....	94.66	Lot 3; SE$\frac{1}{4}$ of NW$\frac{1}{4}$; SW$\frac{1}{4}$ of NE$\frac{1}{4}$. City owns land. Kent Lbr. Co. reserves timber till July 1, 1941.
....	20.00	N$\frac{1}{2}$ of NW$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land. J. B. Allen reserves timber till January 30, 1922.
....	58.21	Lots 1 and 2 and SE$\frac{1}{4}$ of NE$\frac{1}{4}$, except R-W of C. M. & St. P. R. R. City owns land. Kent Lumber Co. owns timber.
....	139.42	Portion of SW$\frac{1}{4}$. City owns land. Mill. Land Co. owns timber.
....	20.51	Portion of SW$\frac{1}{4}$. City owns land. J. K. Stack reserves timber.
5	543.68	Entire Sec. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
6	152.58	Lots 3, 4, 5, 6, 7 and 8. City owns land, timber and minerals.
....	487.71	Lots 1, 2, 9, 10, 11, 12, 13 and 14. City owns land and minerals. Kent Lbr. Co. has timber rights till July 1, 1941.
7	308.96	Lots 7, 11 and 12; W$\frac{1}{2}$ of SE$\frac{1}{4}$; NE$\frac{1}{4}$ of SE$\frac{1}{4}$; S$\frac{1}{2}$ of NE$\frac{1}{4}$, except R-W of C. M. & St. P. Ry. City owns land and mineral rights; also timber on Municipal R-W. Timber on rest of area reserved by N. P. Ry. Co
....	431.19	Lots 1, 2, 3, 4, 5, 6, 8, 9 and 10; N$\frac{1}{2}$ of NE$\frac{1}{4}$ and SE$\frac{1}{4}$ of SE$\frac{1}{4}$. City owns land. Kent Lbr. Co. reserves timber till July 1, 1941.
8	265.39	SW$\frac{1}{4}$; NE$\frac{1}{4}$, except Municipal R-W. City owns land. Mil. Land Co. reserves timber.
....	262.71	SE$\frac{1}{4}$; NW$\frac{1}{4}$, except Municipal R-W. City owns land. Kent Lbr. Co. reserves timber till July 1, 1941.
....	46.93	Municipal R-W in NE$\frac{1}{4}$; except R-W of C. M. & St. P. Ry., 6.39 acres. City owns land.
....	50.90	Municipal R-W in NW$\frac{1}{4}$; except R-W of C. M. & St. P. Ry., 6.39 acres. City owns land.
9	480.00	S$\frac{1}{2}$; SE$\frac{1}{4}$ of NW$\frac{1}{4}$; S$\frac{1}{2}$ of NE$\frac{1}{4}$; NE$\frac{1}{4}$ of NE$\frac{1}{4}$. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
....	5.00	Portion of NE$\frac{1}{4}$ of NW$\frac{1}{4}$, lying N of Cedar River. City owns land, timber and minerals.

Sec.	Area, Acres	Description
....	155.00	W½ of NW¼; NW¼ of NE¼; portion of NE¼ of NW¼; lying S of Cedar River. City owns land, coal and mineral rights. N. P. Ry. Co. reserves timber.
10	640.00	Entire sec. City owns land and minerals. Weyerhauser Timber Co. reserves timber till July 1, 1946, except on portion of NE¼ of NE¼ lying N of Cedar River, where City also owns timber.
11	360.00	S½; SW¼ of NW¼. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
....	80.00	SE¼ of NW¼; SW¼ of NE¼. City owns land, coal and minerals. N. P. Ry. Co. owns timber.
....	200.00	N½ of N½; SE¼ of NE¼. City owns land, timber and minerals.
12	599.40	Entire fractional sec. City owns land, timber and minerals.
13	400.00	W½; S½ of SE¼. City owns land, timber and minerals.
....	146.65	Lots 1, 2 and 3; NW¼ of SE¼. City owns land, coal and minerals. N. P. Ry. Co. owns timber.
15	640.00	Entire sec. City owns land. Weyerhauser Tbr. Co. reserves timber till July 1, 1946, also owns mineral rights.
16	160.00	N½ of N½. City owns land. Timber belongs to Kent Lbr. Co.
17	640.00	Entire sec. City owns land. Weyehauser Tbr. Co. owns timber to July 1, 1946, also owns mineral rights.
18	160.00	E½ of E½. City owns land and minerals and coal. Pacific States Lbr. Co. have right to once log.
....	160.00	W½ of SE¼; Lots 7 and 12. City owns land, timber and minerals.
....	132.93	Lots 8, 10 and 11, and part of Lot 9. City owns land. Mil. Land Co. owns timber.
18	5.67	Part of Lot 9, Municipal R-W. City owns land. Kent Lbr. Co. reserves timber till October 1, 1914.
....	56.21	Municipal R-W through Lots 1, 2, 3, 4 and 5. City owns land. Timber sold.
....	233.59	W½ of NE¼; Lot 6, parts of Lots 1, 2, 3, 4 and 5, outside of Municipal R-W. City owns land. Milwaukee Land Co. reserves timber.
19	350.18	NE¼; N½ of SE¼; Lots 1 6 and 10. City owns land coal and minerals. Pacific States Lumber Co. has right to once log.
....	409.54	Lots 2, 3, 4, 5, 7, 8, 9, 11 and 12, and S½ of SE¼. City owns land, coal and minerals. N. P. Ry. Co. owns timber.
20	480.00	N½; N½ of S½. City owns land, coal and mineral. Pacific States Lbr. Co. has right to once log.
....	160.00	S½ of S½. City owns land timber and minerals.
21	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
22	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
23	320.00	E½. City owns land, timber and minerals.
....	320.00	W½. City owns land only. Weyerhauser Tbr. Co. reserves timber till July 1, 1946, and owns mineral rights.
25	320.00	W½. City owns land only. Weyerhauser Tbr. Co. reserves timber till July 1, 1946 and owns mineral rights.

Sec.	Area, Acres	Description
....	320.00	E½. City owns land, timber and minerals.
27	640.00	Entire sec. City owns land, coal and mineral rights. P. S. Lbr. Co. has right to once log.
28	520.00	NE¼; E½ of NW¼; SW¼; N½ of SE¼; SE¼ SE¼. City owns land, coal and minerals. P. S. Lumber Co. has right to once log.
29	280.00	N½ of N½; S½ of NE¼; NE¼ of SE¼. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
....	360.00	S½ of NW¼; SW¼; W½ of SE¼; SE¼ of SE¼. City owns land, coal and minerals. N. P. Ry. Co. owns timber.
30	461.16	Lots 1, 2, 3, 4, 5, 6, 7 and 12, and SE¼. City owns land, timber and minerals.
....	160.00	NE¼. City owns land only.
....	142.44	Lots 8, 9, 10 and 11. City owns land. P. S. Lbr. Co. has right to once log.
31	770.20	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
32	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
33	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
34	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
35	640.00	Entire sec. City owns land, coal and minerals. P. S. Lbr. Co. has right to once log.
	18,852.53	Total land owned by City in Township 22 North, Range 8 East, Willamette Meridian.

TOWNSHIP 23 NORTH, RANGE 8 EAST, WILLAMETTE MERIDIAN.

Sec.	Area, Acres	Description
31	200.00	SE¼; SE¼ of NE¼. City owns land and minerals. Weyerhauser Tbr. Co. reserves timber till July 1, 1946.
32	640.00	Entire sec. City owns land. Kent Lbr. Co. owns timber.
33	.34	Tract in SE¼ of SE¼ of SW¼. Municipal R-W. City owns land.
	840.34	Total land owned by City in Township 23 North, Range 8 East, Willamette Meridian.

TOWNSHIP 22 NORTH, RANGE 9 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
5	240.00	SW¼; S½ of SE¼. City owns land only. N. P. Ry. Co. owns timber and minerals.
6	227.77	Lots 4, 5, 6 and 7, E½ of SW¼. City owns land. Milwaukee Land Co. reserves timber.
7	474.09	Entire fractional sec. City owns land, timber and minerals.
9	200.00	S½ of S½; NW¼ of SW¼. City owns land only. N. P. Ry. Co. owns timber and minerals.
16	440.30	NW¼ and S½. City owns land, timber and minerals.
17	456.40	Entire fractional sec. City owns land, timber and minerals.
18	119.26	Lots 1, 2, 3, 4 and 5. City owns land, coal and minerals. N. P. Ry. owns timber.
....	91.55	Lots 6, 7 and 8 and NE¼ of NE¼. City owns land and timber.
19	280.55	Fractional E½. City owns land, timber and minerals.
....	308.88	Fractional W½. City owns land only. N. P. Ry. owns timber and minerals.

Sec.	Area, Acres	Description
20	320.45	SW¼; NW¼; SW¼ of NE¼. City owns land and timber.
....	40.00	SW¼ of SE¼. City owns land, timber and minerals.
....	39.05	Lot 1. City owns land, coal and minerals. N. P. Ry. owns timber.
21	516.60	Entire fractional section. City owns land, timber and minerals.
22	80.00	NW¼ of NW¼; SW¼ of NE¼. City owns land, timber and minerals.
....	320.00	S½ of NW¼; N½ of SW¼; SE¼. City owns land and timber.
....	40.00	SE¼ of SW¼. City owns land, coal and mineral rights. N. P. Ry. Co. owns timber.
23	160.00	SW¼. City owns land, timber and minerals.
25	574.55	Entire fractional sec. City owns land only. N. P. Ry. Co. owns timber, coal and minerals.
26	320.00	N½. City owns land and timber.
....	40.00	NE¼ of SE¼. City owns land, timber and minerals.
27	320.00	N½. City owns land timber and minerals.
....	286.85	S½. City owns land only. N. P. Ry. Co. owns timber and minerals.
28	640.00	Entire sec. City owns land and timber.
29	640.00	Entire sec. City owns land, timber. and minerals.
30	160.00	E½ of E½. City owns land and timber.
....	120.00	W½ of NW¼; SW¼ of SE¼. City owns land, timber and minerals.
31	125.36	NE¼. City owns land, timber and minerals.
....	483.33	W½; SE¼. City owns land only. N. P. Ry. Co. owns timber and minerals.
33	463.10	E½; SW¼. City owns land only. N. P. Ry. Co. owns timber and minerals.
....	160.00	NW¼. City owns land timber and minerals.
35	640.00	Entire sec. City owns land only. N. P. Ry. Co. timber and minerals.
36	640.00	Entire sec. City owns land timber and minerals.
	9,968.09	Total land owned by City in Township 22 North, Range 9 East, Willamette Meridian.

TOWNSHIP 22 NORTH, RANGE 10 EAST, WILLAMETTE MERIDIAN

Sec.	Area, Acres	Description
19	159.21	S½ of S½. City owns land timber and minerals.
27	40.00	SW¼ of SE¼. City owns land, timber and minerals.
....	80.00	S½ of SW¼. City owns land only. N. P. Ry. owns timber and minerals.
29	80.00	N½ of NW¼. City owns land only. N. P. Ry. owns timber and minerals.
....	320.00	S½ of NW¼; SW¼; S½ of SE¼. City owns land, timber and minerals.
31	600.00	Entire sec., except SE¼ of SW¼. City owns land, timber and minerals.
....	40.00	SE¼ of SW¼. City owns land, coal and minerals. N. P. Ry. Co. owns timber.
33	640.00	Entire sec. City owns land, timber and minerals.
35	520.00	S½; S½ of N½; NE¼ of NE¼. City owns land only. N. P. Ry. Co. owns timber.
36	640.00	Entire sec. City owns land, timber and minerals.
	3,119.21	Total land owned by City in Township 22 North, Range 10 East, Willamette Meridian.
	43,825.18	Grand Total of land owned by City in Cedar River Watershed.
	68.48 sq. miles.	

U. S. NATIONAL FOREST LANDS IN THE CEDAR RIVER WATERSHED.

TOWNSHIP 22 NORTH, RANGE 8 EAST, WILLAMETTE MERIDIAN 2,000 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
14	640.00	Entire
24	640.00	Entire
26	640.00	Entire
28	80.00	W½ of NW¼

TOWNSHIP 21 NORTH, RANGE 9 EAST, WILLAMETTE MERIDIAN 4,660.14 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
2	551.80	Entire fractional
4	552.08	Entire fractional
6	556.26	Entire fractional
8	440.00	N½; E½ of SE¼; NW¼ of SW¼
10	640.00	Entire
12	640.00	Entire
14	640.00	Entire
16	280.00	NE¼; N½ of NW¼; SE¼ of NW¼
22	200.00	NE¼; NE¼ of NW¼
24	160.00	N½ of NW¼; SW¼ of NW¼; NW¼ of NE¼

TOWNSHIP 22 NORTH, RANGE 9 EAST, WILLAMETTE MERIDIAN 4,149.57 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
6	390.72	Lots 1, 2, 3 and 8; NE¼; E½ of SE¼
8	630.84	Entire fractional
10	169.80	Lots 1, 2, 3, 4
14	294.10	Lots 1, 2, 3, 4, 5, 6; NW¼ of SE¼
20	131.50	Lot 2; N½ of SE¼; SE¼ of SE¼
22	199.72	Lots 1, 2; NW¼ of NE¼; NE¼ of NW¼; SW¼ of SW¼
24	481.01	Lots 3, 4; S½ of NW¼; S½
26	244.65	Lots 1, 2, 3, 4; SW¼ of SE¼; S½ of SW¼
30	347.81	Lots 1, 2, 3, 4, 5; E½ of SW¼; NW¼ of SE¼
32	649.34	Entire fractional
34	610.08	Entire fractional

TOWNSHIP 21 NORTH, RANGE 10 EAST, WILLAMETTE MERIDIAN 7,363.04 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
2	535.08	Entire fractional, except part of "Copper Queen" Lode, 12 acres.
4	508.72	Entire fractional, except Robinson Lode and Robinson Extension Lode, 40 acres.
6	551.49	Entire fractional
8	640.00	Entire
10	640.00	Entire
12	642.00	Entire fractional
14	640.00	Entire
16	640.00	Entire
18	640.00	Entire
20	360.00	N½ of NW¼; NE¼; E½ of SE¼; NW¼ of SE¼
22	640.00	Entire
24	643.60	Entire fractional
26	160.00	N½ of NE¼; SE¼ of NE¼; NE¼ of NW¼
36	122.20	Lot 1; NW¼ of NE¼; NE¼ of NW¼

TOWNSHIP 22 NORTH, RANGE 10 EAST, WILLAMETTE MERIDIAN 2,155.50 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
28	240.00	SW¼; SE¼ of SE¼; SW¼ of NW¼
30	635.50	Entire fractional
32	640.00	Entire
34	640.00	Entire

TOWNSHIP 21 NORTH, RANGE 11 EAST, WILLAMETTE MERIDIAN 1,817.39 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
6	607.39	Entire fractional
8	320.00	W½
18	644.00	Entire fractional
30	246.00	Lots 1, 2, 3, 4. E½ of NW¼

Total National Forest Land in Watershed, 22,145.64 acres or 34.60 square miles

NORTHERN PACIFIC RAILWAY LANDS IN CEDAR RIVER WATERSHED, WHICH WILL BE TRANSFERRED TO THE CITY WHEN PATENT IS ISSUED.

TOWNSHIP 21 NORTH, RANGE 9 EAST, WILLAMETTE MERIDIAN 4,896.35 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
1	551.44	Entire fractional section
3	552.00	Entire fractional section
5	553.36	Entire fractional section
7	319.55	NE¼; N½ of NW¼; SE¼ of NW¼; NE¼ of SE¼
9	640.00	Entire Sec.
11	640.00	Entire Sec.
13	640.00	Entire Sec.
15	520.00	N½; SE¼; SE¼ of SW¼
23	480.00	N½; N½ of S½

TOWNSHIP 21 NORTH, RANGE 10 EAST, WILLAMETTE MERIDIAN 7,626.51 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
1	542.59	Entire fractional
3	548.96	Entire fractional
5	548.96	Entire fractional
7	640.00	Entire
9	620.00	Entire, except "Viola" Lode Claim
11	640.00	Entire
13	642.40	Entire fractional
15	640.00	Entire
17	640.00	Entire
19	80.00	N½ of NE¼
21	640.00	Entire
23	640.00	Entire
25	643.60	Entire fractional
27	160.00	N½ of N½

TOWNSHIP 21 NORTH, RANGE 11 EAST, WILLAMETTE MERIDIAN 1,446.91 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
5	439.13	W½; SW¼ of NE¼; W½ of SW¼
7	640.48	Entire fractional
17	40.00	NW¼ of NW¼
19	327.30	W½

TOWNSHIP 22 NORTH, RANGE 11 EAST, WILLAMETTE MERIDIAN 217.54 ACRES AS FOLLOWS

Sec.	Area, Acres	Description
31	217.54	Lots 1 and 2; W½ of SE¼; SE¼ of SE¼

Total Northern Pacific Lands, 14,187.31 acres or 22.17 square miles

LANDS ACQUIRED BY CONDEMNATION AND PURCHASE FROM WATER FUND

Cause	25333	and 24650	$ 26,244.04
Cause	31510		13,500.00
Cause	28363		1,071.40
Cause	34001		53,002.00
Cause	52927		23,054.00
Cause	52190		20,200.00
Cause	73356		1,525.50
			$138,596.94
Deed	69	Sec. 7, T. 22 N., R. 9 E.	5,380.85
Deed	350	Sec. 4, T. 22 N., R. 8 E.	500.00
Deed	79	Sec. 4, T. 22 N., R. 8 E.	550.00
Deed	70	T. 22 N, R. 7, 8 and 9 E.	4,323.50
Deed	71	and 86 Sec. 12, T. 22 N., R. 8 E.	4,100.00
Deed	77	Sec. 12, T. 22 N., R. 8 E.	1,700.00
Deed	87	Sec. 30, T. 22 N., R. 8 E.	500.00
Deed	294	Sec. 9, T. 22 N., R. 7 E.	1.00
Deed	68	Sec. 5, T. 22 N., R. 6 E.	27.25
Deed	90	Sec. 8, T. 22 N., R. 6 E.	75.00
Deed	217	Sec. 22, T. 22 N., R. 6 E.	50.00
Deed	89	Sec. 22, T. 22 N., R. 6 E.	75.00
Deed	71	Sec. 23, T. 22 N., R. 6 E.	334.48
Deed	84	Sec. 23, T. 22 N., R. 6 E.	314.69
Deed	73	Sec. 24, T. 22 N., R. 6 E.	200.00
Deed	83	Sec. 24, T. 22 N., R. 6 E.	125.00
Deed	....	Renton Co-operative Coal Co.	3.00
Deed	....	Sec. 17, T. 23 N., R. 5 E.	200.00
Deed	335	Sec. 18, T. 23 N., R. 5 E.	1.00
Deed	74	Sec. 25, T. 23 N., R. 5 E.	120.00
Deed	....	Sec. 11, T. 23 N., R. 4 E.	142.00
Deed	56	to 61 Dunn's Addition	4,900.00
Deed	552	East Park Addition	1.00
Deed	710	Furth's Addition	5,500.00
Deed	993	and 1530 Grand Bvld. Addition	8,140.00
Deed	5938	Latona Addition	1,125.00
Deed	462,	463, 365 and 542 Maple Leaf	5.300.00
Deed	66	J. H. Nagle's 2d Addition	7.620.00
Deed	437	Perkin's Green Lake Addition	14,000.00
Deed	....	Pitner's 3d Div. Green Lake	14,670.00
Deed	883	Scenic Heights Addition	1,600.00
Deed	878	Steel Works Addition	2,200.00
Deed	714	Sommerville's 5 Acre Tracts	1,000.00
Deed	440	and 466 Vacher's Div. to Green Lake	2.442.00
Deed	503	Sec. 21, T. 24 N., R. 4 E.	7,000.00
Deed	502	Sec. 26, T. 22 N., R. 9 E.	500.00
Deed	4492	Sec. 22, T. 23 N., R. 8 E.	2.00
		Fauntleroy Crest Addition, Lots 11, 12, 13 14, Blk. 6	2,186.73
			$ 96,909.50

BY M. L. & P. FUND RE-IMBURSED FROM WATER FUND, ORDINANCE NO. 13186, JANUARY 9, 1906.

Cause	42455	Sec. 20, T. 22 N. R. 7 E.	$ 14,651.40
Deed	374	Sec. 18, T. 22 N., R. 8 E.	343.63
Deed	364	Sec. 4, T. 22 N., R. 8 E.	600.00
Deed	368	Sec. 23, T. 22 N., R. 7 E.	7,273.90
			$ 22,868.93

BY C. R. W. S. EXT. 1910 FUND.

Deed	4883	Sec. 18, T. 22 N., R 8 E.	$ 50,000.00

BY C. R. W. S. COND. FUND.

Cause	75069		$ 367,414.30
Deed	5850	Sec. 4, T. 22N., R. 7 E.	807.50
Deed	5940	Sec. 12, T. 22 N., R 7 E.	73,500.00
Deed	5843	Sec. 2, T. 22 N., R. 8 E.	2,300.00
Deed	6073	Sec. 8, T. 22 N., R. 8 E.	458.98
Deed	6069	Sec. 18, T. 22 N., R. 8 E.	66.94
Deed	6070	Sec. 6, T. 22 N., R. 9 E.	627.39
Deed	5842	Sec. 26, T. 23 N., R. 7 E.	61.91
Deed	4490	Sec. 26, T. 23 N., R. 8 E.	2.00
Deed	6497	Sec. 4, T. 21 N., R. 8 E., Lots 1 and 2	235.50
Deed	6614	Sec. 34, T. 23 N., R. 8 E., Lots 1 and 2	348.07
Deed	6555	Sec. 34, T. 23 N., R. 8 E., Lots 1 and 2	87.75
Deed	6346	Sundry tracts	3,750.00
Deed	6072	Sec. 4, T. 22 N., R. 8 E.	1,847.83
Deed	6071	Sec. 4, T. 22 N., R. 8 E.	627.39
			$ 452,135.56

BY GENERAL FUND .

Deed	39	Denny-Hoyt Addition	$ 350.00
Deed	67	Sec. 9, T. 22 N., R. 8 E.	125.00
Deed	86	Sec. 19, T. 22 N., R. 7 E.	275.00
Deed	72	Sec. 11, T. 22 N., R. 5 E.	502.46
Deed	62	Mercer's 2d Addition (Appraised) (With Union Water Co. System.)	5,000.00
Deed	....	Terry's 2d Addition (Appraised) (With Spring Hill Water System.)	9,000.00
Deed	....	Sec. 10, T. 22 N., R. 4 E. (Appraised) (With Spring Hill Water System.)	20,000.00
Deed	....	Burke's 2d Addition (Appraised) (With Spring Hill Water System.)	20,000.00
Deed	....	Central Seattle Addition (Appraised) (With Spring Hill Water System.)	12,000.00
Deed	....	McNaught's 3d and J. C. Kinnear's (Appraised) (With Spring Hill Water System.)	20,000.00
Deed	291	Sec. 16, T. 24 N., R. 4 E.	11,771.00
			$99,023.46

BY PARK DEPARTMENT.

Deed	66	J. H. Nagle's 2d Addition	$ 3,179.10

BY ANNEXATION.

CITY OF BALLARD			
Gilman Park Addition (Appraised)			5,000.00
Deed	657	Sec. 2, T. 25 N, R. 3 E.	1,500.00
TOWN OF COLUMBIA			
Deed	1802	Sec. 21, T. 24 N., R. 4 E.	1,000.00
			$ 7,500.00

C. R. W. S. COND. FUND.

Ordinance No. 31485	Timber on Sec. 20, T. 22 N., R. 9 E.	9,000.00
Total Appraised valuation Dec. 31, 1913		$1,236,588.22

The present water rates in Seattle are very low. This will be manifest if we compare the rates with those charged in other coast cities. Expressing the quantity of water delivered to consumers in Seattle at various rates as 100 per cent the quantities delivered for the same price in other cities on the coast may be expressed as percentages of 100. The comparison will then show up as follows:

COMPARISON OF QUANTITIES OF WATER FURNISHED, IN PER CENT

City	$0.50	$0.75	$1.00	$2.00	$3.00	$4.00	$5.00	$10.00	$15.00	$20.00
Seattle	100	100	100	100	100	100	100	100	100	100
Los Angeles		117	107	95.2	91.8	90.2	89.3	87.5	86.9	82.8
Portland		71	64	61.7	61	60.8	60.6	60.3	60.3	57.5
Oakland				27.8	26.8	26.3	26.1	26.7	27.2	26.4
SAN FRANCISCO										
Residence and Business rate				23.2	22.3	22	21.7	21.7	22.2	21.8
Rate for shipping supplied through regular service							11	10.7	10.7	10.3
Rate for shipping supplied by hose and reel							4.8	4.7	4.7	4.5

In two cases only is the quantity delivered for a given price greater than in Seattle, and in that city the minimum rate is 75 cents as against a minimum of 50 cents in Seattle.

Conclusion

The tendency which has developed during the last quarter of a century, and which has become at the present date almost a settled policy on the part of many municipalities, to own and operate under public authority forms of business which, under private ownership, require a franchise in order to build and maintain a plant, found its most complete expression in the building and operation of municipal water plants. It is no longer worth any man's while to argue that a water plant under municipal ownership and control cannot furnish a cheap and adequate supply of water to the inhabitants of a city under any conditions which would enable a privately owned plant to perform the same service.

Broadly speaking, the municipal water plant of the City of Seattle has been built and is maintained from two sources of revenue—the local improvement assessments, which amount to about one-third of the cost of the plant, and receipts from water services, from which are paid the interst and redemption on the bonded debt, and operating charges, together with a considerable item of new construction.

Up to the 1st of January, 1914, the plant has cost, exclusive of real estate, $11,707,323.38—$3,767,171.77 of which has been paid, or will be paid, as local improvement assessments, leaving the sum of $7,940,-151.61 to be paid from the earnings of the plant. Of the total bonded and warrant indebtedness issued up to the 1st of January, 1914, amounting to $6,211,980.00, $1,362,739.19 has been paid, leaving a balance due of $4,849,240.81. Both the amount of interest and the amount of redemption to be paid will vary from year to year, the interest falling as the debt is liquidated, and the redemption rising under the terms of the original issue of warrants and bonds for the construction of the Cedar River Water Plant—the interest for the year 1913 amounting to $244,820.70, and the redemption to $235,566.40. These two amounts taken together aggregate $480,387.10, which is 55 per cent of the income of the plant for the year.

Operation and maintenance amounted to $198,070.52; reconstruction and real estate purchases to $21,745.53; new construction, $135,-947.30, of which $60,944.87 was for new taps and new meters, leaving $75,002.43 invested in other new construction, and an uninvested surplus of $36,277.38.

Cedar River Pipe Line No. 1 will require increased appropriations for repairs, the cost of which will multiply rapidly as the years go by.

In connection with the expenses noted it is manifest that the cost of supplying water to consumers is not occasioned by the cost of merely delivering the water—that is, the operating and maintenance charge—but rather, and to a far greater extent, by the cost of installing the complete plant or equipment which is necessary to impound and convey the water.

It would appear just that these costs, to the extent that the benefits coming from them are general, should be charged against the area of the whole city. Where the benefit is only local, as in the case of small distributing mains with their gates and hydrants the cost should manifestly be borne by local improvement assessments against the special district benefited.

The capital investment in the plant against each man employed is $75,000. The average pay received for each day's time worked by each employee being $3.16.

Pipe Line No. 1 has been in use thirteen years and is becoming very unreliable as a supply on account of the decay of the wooden staves. During the summer of 1913 it had to be shut down several times for repairs, and it was found that No. 2 was strained to the limit to maintain the supply, even when all sluicing operations in the city were suspended. This would indicate a consumption during dry weather of some 40,000,000 gallons, or over 133 gallons per day per capita. It is clear that in order to avoid an annual water shortage during the dry season the wooden staves in No. 1 will soon have to be renewed, and, before many years, if the city continues to grow, an additional pipe line will become an imperative necessity. Eighty-five per cent of the services are metered, so that wanton wastage cannot be great, but the rates are so moderate that people do not stint themselves in the use of water, as shown by the high average consumption.

In some districts in West Seattle the water is now being pumped twice in order to get it high enough for use. This pumping entails a cost more than twice the price received for the water. There can be no relief from this condition until reservoirs are established in that district and water-driven pumps installed, similar to those now in operation at Lincoln Park Station.

There have been nine reductions in water rates since the city took over the Spring Hill plant in 1890, until now the fixed rates are less than one-third of what they were then, and the meter rates less than one-fifth.

At the present rate of 6 cents per 100 cubic feet for all quantities in excess of 500 cubic feet, water costs one-fourth of a cent per barrel, or 2 cents per ton. That is less than it would cost a consumer to hire a man at $2.50 per day to lift it with a bucket; less than earth can be handled by steam shovel or otherwise; less than any commodity can be transported 30 miles by boat or rail.

If the average summer consumption be placed at 40,000,000 gallons per day, and the average winter consumption at 30,000,000, we will have an average for the year of 35,000,000. The income of the plant so far as water rates are concerned must clearly come from the sale of this latter quantity. When the winter consumption rises to 44,000,000 the summer will be one-half greater, making 66,000,000, which equals the capacity of both pipe lines. A new pipe line will then be urgently needed to avoid a shortage in the dry season.

If we divide the annual revenue of $872,446.83 by the present physical value of the plant, $11,297,031.00, we shall find that the gross income amounts to 7.7 per cent of that value. Of this return 4.25 per cent or $480,387.10 went to pay interest and redemption on the debt, and 3.45 per cent, or $392,409.93 was left to pay operating, maintenance, construction, reconstruction and real estate. Of this balance $198,070.52 went for operating and maintenance, leaving $194,339.41 for other purposes, including the purchase of meters and installation of new taps.

All public service institutions must bear criticism. Much of this is, inevitably, one-sided and unjust. General conclusions are too often drawn from a single incident; and are frequently valueless on account of being prompted by personal feeling, with but little knowledge or consideration of the general public interests involved. The Water Department has, doubtless, had its share of this criticism; but through it all the vital fact stands forth that rates have steadily fallen, while the quantity and quality of the service has been maintained and improved.

INDEX

A

B

C